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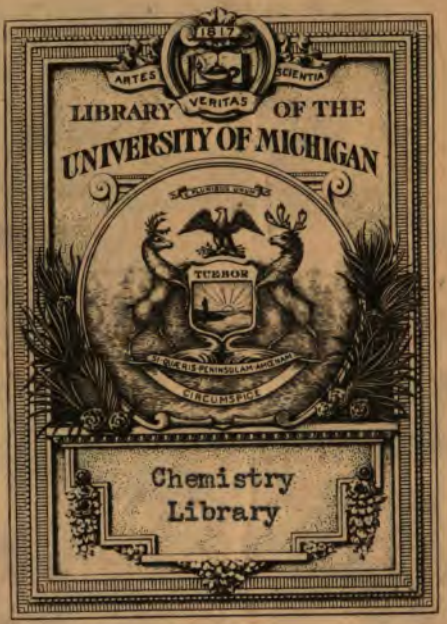

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TABLES

FOR THE

DETERMINATION OF MINERALS

BY THOSE

PHYSICAL PROPERTIES

ASCERTAINABLE BY THE AID OF SUCH SIMPLE INSTRUMENTS AS EVERY STUDENT IN THE FIELD SHOULD HAVE WITH HIM.

BASED ON THE TABLES OF albin WEISBACH.

ENLARGED, AND FURNISHED WITH A SET OF MINERAL FORMULAS, A COLUMN OF SPECIFIC GRAVITIES, AND ONE OF THE CHARACTERISTIC BLOWPIPE REACTIONS.

BY

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PREFACE TO WEISBACH'S "TABELLEN," ETC.

"While conducting the exercise of mineral determination in the Academy here, I have noticed that the students, in examining the specimens given to them, often lose much time in looking out and reading the descriptions in the various compendiums of minerals; and this originated in me the desire to place in the hands of those taking this course a means to assist in the diagnosing of minerals; all the more from the fact that the only attempt thus far known, and which was by Dufrenoy,* to help the determination of minerals by their physical characteristics, can scarcely be said to have been a success. On the other hand, in the tables of von Kobell† and Dana,‡ the chemical behavior has been selected as the main principle of classification, whose employment, it is true, in itself and for a single student, is very good, nevertheless in a larger class associates with itself many disadvantages when the students are not sufficiently conversant with the physiognomy of minerals.

From this cause I determined to sketch out a plan of arrangement for myself in the main based upon the outward characteristics, which now appears in the following pages.

In this I have divided minerals into three tabular systems, of which the first (pp. 12–30) embraces those of metallic lustre; the second (pp. 30–56) those of non-metallic lustre which give a colored powder; and lastly, the third (pp. 56–104) contains all minerals of non-metallic lustre and colorless streak. These three systems of tables fall again into single tables (for example, the first into five), in which the minerals are arranged according to their hardness,—*i.e.* the softest are placed first, and the hardest last.

It follows from this, that when a given piece of a mineral is to be determined by the aid of the tables, one must first ascertain the kind of lustre, the degree of hardness,§ the streak, and (with metallic habit) also the color. If these characteristics are determined correctly,—and their determination is so easy,—one will be confined by the tables to a small number from which the choice must be made; out of which the correct one can be found sometimes immediately, and sometimes with the assistance of a special search in a text-book of mineralogy, but almost always without difficulty, provided the crystal system be plainly visible; if this characteristic be wanting, the determination will be more difficult, or at least more tedious, especially when the mineral belongs to the class of those with non-metallic lustre and colorless streak.

In such a case the number of those minerals from which the choice must be made turns out to be very large, and it then seems advisable to call to aid the appended tables (pp. 104 to 113 inclusive), in which the behavior of the mineral in the glass matrass, its behavior when treated with water and hydrochloric acid, as well as the degree of its fusibility, are given; indeed, with powdery constitution, and at the same time white or gray color, the use of these supplementary tables will become very necessary, and a further chemical examination unavoidable.

This latter course is anyhow advisable in all cases of doubt, and herewith particularly the employment of the blow-pipe to be recommended, which appears in its proper sphere as an aid in determining small mineral masses, and besides this does good service in the determination of white, gray, and black minerals of metallic lustre," etc.

* Dufrenoy, Traité de Minéralogie, 2e édit., i. 529–703.

† F. v. Kobell, Tafeln zur Bestimmung der Mineralien mittelst einfacher chemischer Versuche auf trockenem und nassem Wege.

‡ J. D. Dana, A System of Mineralogy, 4th edit., i. 261–310.

§ I cannot refrain from remarking that the succession of species of like degree of hardness does not always occur in a manner perfectly satisfactory to me, inasmuch as related minerals could have been placed nearer together. In this respect pp. 58 and 68 require a rearrangement.

INTRODUCTION.

In June, 1873, I received a letter from the author of the "Tabellen zur Bestimmung der Mineralien," from which I extract the following lines: . . . "Was die von Ihnen beabsichtigte Uebersetzung meiner mineralogischen Tabellen betrifft, so gebe ich hiermit gern dazu meine Zustimmung und Erlaubniss; freilich ist manches darin veraltet." . . .

These words of my former Professor I have thought well to place at the head of these remarks, in order that I might, while acknowledging my indebtedness for his kindness, exhibit my legitimation for this work.

Every one who has had the good fortune to study at the Royal Saxon Mining Academy, in Freiberg, will bear witness to the efficacy of the system there pursued for instructing young students in the art of distinguishing mineral species on the spot, by the aid of a tolerable memory and an intelligent observation of a few of their most striking physical properties,—both brought to the highest point of perfection of which they are capable by judicious cultivation, and kept in their best condition by assiduous daily exercise.

The method of practical instruction pursued there, and which has been introduced by Freiberg graduates into many schools in this country, requires merely a cabinet of unlabeled minerals, and a Professor who can determine—not one who has *learned*—them. Each student of a class of ten or more places a tray of such minerals before him, and occupies the two hours devoted to "Praktischer Uebung" in discovering, by the aid of the knife, the streak-tablet, the file, and the magnifying-glass, the true nature of as many of these minerals as possible. There is, however, a large class of minerals (the silicates, etc.) which, unless distinctly crystallized, present considerable difficulties to the field-worker. To partly overcome these difficulties the supplementary tables were added by Prof. Weisbach, whereby, through the instrumentality of a bottle of acid, a matrass, a blow-pipe, and a couple of fluxes, a still larger number of species can be identified.

But all will admit that no tables based upon purely physical properties can enable one to identify *all* species; though the greater one's experience in the field, the fewer minerals will require a laboratory investigation.

There are three applications for which these tables were more particularly designed:—

The first is in the class-room, as an artificial memory to the student practicing instantaneous determination; the second is for the prospector, geologist, or mineralogist in the field, as an occasional reminder of some point which was escaping his attention, and to suggest the simplest methods of discovering the identity of minerals if the physical tests fail; and third, they may prove serviceable to him who, though neither geologist nor mineralogist, is impelled by business or love of nature to collect minerals.

It is proper to state that this work was undertaken and carried through amid responsible duties connected with the Pennsylvania geological survey, and that in spite of every effort to eliminate errors, many will perhaps remain in the text unnoticed until it is too late to correct them.

My aim throughout has been to follow the original design of Prof. Weisbach as closely as circumstances would permit, but certain changes were unavoidable in presenting this work to the American public, and I have not hesitated to make them.

These changes are partly of the nature of alterations of some of the minor details of his method, and partly of the nature of additions or alterations to his original scheme.

By referring to Weisbach's Preface, and comparing his remarks with the present work, it will be observed that many of them are inapplicable to it.

In America mineralogists have very generally agreed to consider Dana's last edition as authority on most disputed questions, and in nothing does this great work more clearly show the incredible industry, care, and the good judgment of its author than in the considerations which have influenced him in regard to the choice of names for minerals. He has given to this essential though less professional part of the subject so much thought, has weighed so fairly and justly the claims of rival claimants to the right of naming, and has altered objectionable names with such independence and ability, that it would be strange indeed if an American book on any branch of the subject did not make Dana's nomenclature the basis of its own. This has been done in the present tables. The names of the kinds of colors are generally not very different in Dana and Weisbach, and these have, except occasionally, been left as the latter has them. In the kinds and degrees of lustre, it was more difficult to adopt any rigorous law governing their presentation, and while the reader will find Dana's terms usually employed, the description will be found now to be that of Weisbach, now that of Dana, and again that of some third authority (especially Naumann), where circumstances seem to call for the alteration.

To symbolize particular crystal forms, as well as to indicate the systems to which they belong, use has been made of Dana's abbreviations, though in a number of instances, where the two mineralogists disagreed, the datum of one or the other was taken according to the supposed weight of testimony in his favor. This change of crystallographic symbol, which is merely an outward sign, is likely to be the first to strike the eye of those accustomed to the simple and easily understood designation of Naumann; but it was justified, in the opinion of the subscriber, by its greater succinctness, as well as by the fact that it has already to a great extent become domiciled in this country as the American crystallographic language.

It was sought to simplify the tables as much as possible by the omission of all signs and marks which were not necessary to the determination of the mineral. With this view the bracket around the abbreviation for the crystal system was omitted, and the student was tacitly referred to the larger text-books for the information which this conveyed in the original "Tables" (see Weisbach's Preface, remark 7); or if important, it was assumed that by giving the system, and omitting all else, the intelligent reader would understand that the former was concluded from the optical peculiarities of the mineral.

The reason for omitting the brackets around the names of those minerals which are not indigenous to Germany is so obvious as not to need explanation; and I trust that the omission of the graduated type to indicate the minerals which are common, or occur not unfrequently, from those that are rare, will be considered not less justifiable by those who use these tables. It is a difficult thing anywhere to say what minerals are rare and what common, but the difficulty increases enormously with the area to which the restriction refers, and in a country as large as ours no attempt at limiting the occurrence of minerals would seem to be generally possible which did not include a separate condensed list of known localities, etc., which would greatly burden an unpretentious little book like this. With this view the subscriber has printed the names of all minerals in the same type, and trusted to the enlarged description to enable the student to distinguish them apart.

Many minerals in the original text have been omitted in this work, and others have been introduced.

With regard to the other kind of change,—*i.e.* the enlargement of Prof. Weisbach's plan,—the undersigned has introduced under the head of "Remarks" first, a number which expresses the mean of the different determinations of specific gravity for every mineral, believing this course to be in many respects better than the restriction of the datum to cases where it becomes a distinguishing characteristic; and that when it *is* a distinguishing characteristic, the real number expressing it is a better clue to its identity than the symbol < 6, which is true of iron as well as platinum. Besides this, no one

can tell what circumstances in connection with the occurrence of a mineral may make it desirable to know as nearly as possible its real specific gravity; and as this is pre-eminently a physical characteristic, and perhaps the most important of all, it seems to be in place in a table which professes to give a physical sketch of the mineral.

Every real student will scan such a table carefully and with thought, and if in the midst of a series of minerals having a sp. gr. of 2.25 to 3.25 he comes upon one having sp. gr. 6 to 7 (as *cassiterite*, for example) it will scarcely be necessary to call his attention to it by the unusual occurrence of a sign under "Remarks;" but when this sign is >4, and the very minerals in its neighborhood from which it is intended to distinguish it have themselves either a sp. gr. greater than 4 or under 4 by less than 1, it seems unadvisable to adopt this arrangement.

But the greatest divergence from the original plan of Prof. Weisbach consists in the added column of chemical formulas and the *preliminary* note of blow-pipe reactions, also added under "Remarks." As to the latter, it is intended to supply the means of immediately applying a crucial test to decide the identity of a mineral already selected as the one in question by the use of the tables; as the supplementary tables contain a short synopsis of a systematic course of procedure to arrive at the true character of a mineral as yet unknown.

The tests are generally taken from Dana's large and latest work, and are added wherever it was thought they were needed to supply such help.

The column of chemical formulas was introduced to supply what I know many of the sincerest admirers of Prof. Weisbach's general system have felt to be a want in his tables,—a knowledge of the chemical constitution of the mineral. Not only does the beginner feel his information as to a mineral incomplete without this essential characteristic, but the very chemical nature of a mineral will sometimes decide whether under the circumstances of its occurrence it can be what it was supposed to be. It certainly does not detract from the usefulness of the tables as a means of determining minerals by purely physical tests, that one should be able by these tests to assign their proper chemical constitution.

Every true mineral is a definite chemical compound, or element, homogeneous throughout its parts, and capable of expression in a formula which represents—at least—the proportions in which the atoms of the same or different elements are associated together in its molecule.

Its molecule is a distinctive whole,—the unit of its mass,—and incapable of division so long as the mineral retains its characteristic properties; and any formula which represents the mineral as consisting of two compounds is in antagonism with this fundamental principle, and can convey no clear idea of unity to the mind.

Starting with these postulates, as soon as I had decided to add a column of formulas to the tables, I determined to try, to the best of my ability, to reconcile the most reliable records of analysis with it, and if possible, in the light of the modern chemistry, to push this effort beyond mere empirical percentages to the construction of rational formulas. I frankly own at the outset my entire responsibility for all the errors into which I may have been drawn, and cheerfully grant that many of my inferences may be mistaken. I only ask consideration for the difficulties under which I have been obliged to carry this heavy labor to consummation; during a campaign in the field, almost entirely without books of reference, and able to give but a small part of my time to it, and that time consisting of a few hours after the conclusion of a day's work. From this cause—I will not deny from other causes also—it is probable that many errors will be found in the work; indeed, the number detected by a review of the plate proofs was discouraging; but I offer it to the mineralogical public rather as an earnest of what I would have it than as what it ought to be; and if it in any way aids in abolishing those mineral formulas into which the sign + is so lavishly introduced, my aim will have been accomplished, though not one of my own suggested formulas should stand.

While overhauling the records of analysis of each mineral which were accessible to

me, to recalculate a formula whose character should express unity, I was forced in some few cases into making bold assumptions as to the manner in which the anion and cathion radicals were strung together, and it is in such formulas that I expect, and shall meekly submit to, criticism.

In the case of some silicates, as, for instance, *Meionite* and *Saussurite*, I have assumed that the total power of the aluminum atoms to satisfy acid radicals is diminished by so many bonds as are represented by the number of atoms of the other cathion element, these bonds uniting the latter as to an acid, and leaving the remainder to be in turn saturated by the acid silicon radical. I confess that this hypothesis does some violence to old accepted notions of chemical union, more particularly as the dyad thus saturating the aluminum must always itself be a stronger cathion than the latter, and therefore more likely to combine with SiO_4. These difficulties are plain, and I can only say that this arrangement agrees with the percentage composition of the minerals as derived from some of the most trustworthy records of analysis, and that I discovered no other which would.

It is necessary for this hypothesis to assume that no aluminum molecule is *completely* saturated with the base, and that none of this base is united directly to $(SiO_4)^{'''}$, for in either case there would be a splitting up of the original molecule into two others.

It is understood, of course, that what I have said as to the exclusion of the sign + from the formulas of minerals has no reference to the molecules of water, which always accompany crystallization in certain minerals; nor have I deemed it necessary to indicate this water by the symbol aq., for the reason that + 6aq., or + 12aq., seems inconsistent with a pure chemical notation.

Simply for convenience, and as an arbitrary method of indicating the parts I have supposed its constituents to be playing in the compound, I have adopted the plan of writing the symbol for the other bases before that of Al_2 *without* a comma when the whole of its combining power is added to that of the latter to saturate the anion radical, and *with* a comma between them when the number of atom-saturating equivalents of the bases was constant, while the proportion to each other of the bases was variable. As, for example: $(R''(R_2)^{V'})(Si^{'V}O_3'')_4''' + 6(H_2O)$, the theoretical formula for Chabazite, means that an atom of a dyad base and a molecule of hexad base together satisfy four molecules of the bibasic radical, $(Si^{'V}O_3'')''$; whereas $(R_2'',(R_2)^{V'})(Si^{'V}O_3'')_3''$ implies a compound in which the six bonds of $(Si^{'V}O_3'')_3''$ are divided in varying proportions between the dyad and hexad base; and $((R_2)^{V'}R'')^{'V}(Si^{'V}O_3'')_2''$ is meant to formulate a compound in which the dyad R'' partially saturates $(R_2)^{V'}$, leaving it but four bonds out of six.

There are minerals scattered through the tables which defied all efforts of mine to bring them into the general fold of those possessing unity of formula, and these have been written simply empirically or with the *relative* number of atoms which their analysis showed, without any attempt to make a formula: such are Boracite, Helvite, Sodalite, etc., whose proper theory awaits solution at abler hands.

I find no better place than here to introduce an explanation of the equivalence marks, which I intended should accompany every atom in every formula. This was done as well to familiarize the beginners in chemistry—insensibly to themselves—with the equivalence values as yet determined, by causing their eyes to rest upon them in connection with the elements to which they refer every time they view a formula; and also to present to the more experienced a theory of composition unexpressed in words. It is true that we soon get to know that the equivalence of Al_2 is six, and of Si is four; that the base-saturating power of $(P^VO_4'')'''$ is three, and of $(Sb^VO_3'')'$ is one, but the extreme complexity of some of the compounds is at once appreciated and its extent measured when the equivalence or basicity for the element or acid radical is placed immediately above the figures expressing the number of such elements or acid radicals in the compound, and only needs to be multiplied by these to give the total chemical work involved, in chemical units of work. Besides this, these signs offer the readiest means of detecting errors of formula, and, in this way alone having rendered me valu-

able assistance in the progress of the work, I was loth to destroy the scaffolding when the structure was about to pass out of my hands. For a similar reason I have appended frequently to the parenthesis inclosing all the bases a Roman numeral, intended to express their total anion-saturating power, where this has been modified by partial saturations among themselves, in order that those who might forget the meaning of this arbitrary arrangement might have their attention directed to this modification, as in the case of Beryl, $Be_3''O_{10}''((Al_2)_3^{V'}O_2'')^{X'VI}O_4''Si^{V'}$, in which O_2'' is regarded as partially saturating $(Al_2)_3^{V'}$, and reducing its total saturating power from XVIII to XIV.

This plan of indicating the total saturating power by numerals is also followed with the para-silicates, that the reader may easily reproduce for himself (*or herself*) the *ortho* form of such a salt.

Wherever it was possible to account for all the atoms of an empirical formula in a rational formula by ascribing to part of the oxygen a saturating function, this was done; but it sometimes happened that the character of the salt was changed with the number of atoms which were supposed to be thus employed. Thus, the empirical formula of Dufrenite is $(Fe_2)_2^{V'},P_2^{V},O_{11}'' + 5(H_2O)$, and these atoms can be arranged to form either an ortho-phosphate, thus: $((Fe_2)_2^{V'}O)^{X}(P^{V}O_5'')_2^{V} + 5(H_2O)$, or a mono-meta, phosphate, thus: $((Fe_2)_2^{V'}O_3'')^{V'}(P^{V}O_4'')_2''' + 5(H_2O)$. In such cases, and in the absence of decisive information as to the state of the acid, that form was selected which seemed most probable.

Again, it occurred that a mineral could be written as a *para-silicate*, or as a double salt of two silicic acids. Thus, Saussurite (whose formula is given on the O ratio, stated in Dana, p. 92) is simplified according to Naumann to the formula $(R_3''(Al_2)_2^{V'})^{XV'''}$-$(Si_5'^{V}O_{19}'')^{XV'''}$, or is the first modification or mono-meta form of a penta-silicate; but it can also be written $(Si'^{V}O_3'')'' = (R_3''(Al_2)_2^{V'})$-16-$(Si'^{V}O_4'')_4'^{V}$,* in which case it could be regarded as a double ortho and mono-meta silicate of the bases, in the proportion of four of the former to one of the latter acid. Or Labradorite $(Ca''Al_2^{V'})^{V'''}$-$Si_3'^{V}O_{10}''$, which is equally intelligible as $(Si'^{V}O_3'')_2'' \equiv (Ca''Al_2^{V'})^{V'''} \equiv (Si'^{V}O_4'')'^{V}$.

In the mineral Wittichenite, the number of atoms being smaller, this is more apparent. Its atom ratio is Cu_4'',Sb_2^{V},S_5'', whence it resolves itself into $S'' = Bi''' — S'' — (Cu_2)_2'' \equiv S_3'' \equiv Bi'''$, or a double ortho and mono-meta sulpho-bismuthite.

The feldspars, according to this system of formulation, all appear as para-silicates, as do some of their near relations, while the amphiboles and pyroxenes admit of an extremely simple representation.

The term *para-silicate* in these pages has been applied to every silicate in which the ratio of the number of atoms of silicon to that of the atoms of oxygen is such as could be explained on the assumption that a *group* of silicon atoms (instead of a single one) formed the nucleus of the radical; and that the *meta* salts were formed from the ortho-para-silicate (which will necessarily be a multiple of SiO_4) by the abstraction of successive molecules of H_2O (or an equivalent) just as in the case of the salt containing but one atom of Si.

In such cases part of the oxygen will be *saturating*, and part linking oxygen, and sometimes in the (as stated above) simpler compounds the *para-silicate* may be considered a mixed ortho and meta silicate; but in any case these compounds can be written as multiples of a *single* ortho-silicate, part of the bonds of the group being saturated by oxygen. For example, Saussurite (as it appears on p. 92) is, according to the formula there given $((R_2)_{16}^{V'}R_{12}'')^{LXX''}(Si_{21}'^{V}O_{78}'')^{LXX''}$, which could be rendered $((R_2)_{16}^{V'}R_{12}'')^{LXX''}O_{72}''—(Si_{21}'^{V}O_6'')^{LXX''}$.

I purposely choose this formula because it is an extreme case, and therefore brings the question of polymerism to this extent directly before one. Is it possible that so complex a formula can represent an apparently simple compound? Every one who has occupied himself with the calculation of mineral formulas knows that occasionally several analyses will agree in giving an atomic ratio in which one element has the same

* In this formula the number 16 preceded and followed by a dash is used to indicate 16 bonds.

fraction over a number which would admit of a formula,—a fraction often which is too large to neglect and too small to reckon, unless all the terms of the ratio are multiplied by a comparatively large factor.* In such cases I have nevertheless performed the multiplication, under the belief that one of the greatest obstacles to mineral formulation has been the conviction that they were simple compounds, whereas, in fact, they are generally polymeres of a high order.

I should explain some of the abbreviations which I have introduced into the text. By the letter (D) in parenthesis, it is intended to indicate that the formula is constructed from Dana's theoretical atomic ratio, or oxygen ratio. When the letter D is followed by one or more figures, these refer to the numbers of the analyses given by him from which the formula was calculated.

Perhaps the interrogation marks are less consistently used after the formulas than they should be, and this is because I felt that a proper resignation to modesty would compel me to put them after all formulas which differed from those of my very highly-respected authorities and superiors in science, and this would have been at once meaningless and monotonous.

Only when some unsuspected difficulty suggested itself did I answer the prick of conscience and make amends by this cabalistic character.

A star has been affixed to the formulas which differ from those in the authorities in some respect, though it is not pretended that any novelty will attach to the formula of quartz because it is written $Si''^{V}O_2''$ instead of SiO_2, least of all that the former formula in any way owes its origin to me; but its construction is analogous to that of the other minerals of this scheme, and, having been fairly angled for out of its analysis, it was duly landed, and branded like the rest.

The printer has found it necessary to substitute a dash for a plain Roman 1, which makes all the diatomic hexad molecules look somewhat as if they were ashamed of themselves and trying to withdraw; but I hope this æsthetic fault will be passed over, in view of the other and more important matters involved.

I am indebted for facts to the mineralogical works of v. Rammelsberg, Berlin, 1843; Naumann, Leipzig, 1874; Dufrenoy, Paris, 1844; Breithaupt, Freiberg, 1836; Del Rio, Mexico, 1832; Girardin, Paris, 1837; Heuland, London, 1838; and last and most, to Dana's System of Mineralogy, New York, 1868. The works on chemistry which I have had at hand are Graham, Otto, Regnault — Strecker, Cornwall's trans. of Richter's Plattner, Fownes (1868), and Barker, New Haven, 1872, to which latter work alone I am indebted for much comfort in the discovery that its able author had already preceded me with formulas for several minerals, which partly agreed with those I had independently evolved, and in a few cases (Cyanite) were better than, and were substituted for, mine.

In conclusion, I beg to remind those who still persist in deeming my rational formulas irrational, that their atomic proportion still remains the same as before, and that such readers may extract all the information from them which they could from the old formulas by disregarding both signs and hypotheses, very much, I must add, as a man might use a chisel for a screw-driver.

P. F., Jr.

York, Oct 2, 1874.

* The fact often suggests itself, too, that part of the complexity is due to some unknown error in the analysis.

PREFACE TO THE SECOND EDITION.

These tables have been altered in the following respects. By the advice of many mineralogists, I have gone back to Weisbach's idea of distinguishing the minerals by symbols according to their frequency or rarity. This frequency, however, no longer refers to country or locality, but to mineral collections of average merit. Minerals without which the smallest collections would not be complete are printed without any mark. Those which, while common enough in collections of some size, might be absent from the very smallest, are furnished with a dagger (†). Minerals which are found only in the largest or finest collections are marked with a double dagger (‡). Lastly, those which, either from their rarity or the incorrectness of their first determination, or from any other cause, I would gladly omit altogether from the tables, were it not that the plates are stereotyped, are furnished with the section mark (§).

It is with great satisfaction that I note in the lately-issued "Text-Book of Mineralogy by Mr. E. S. Dana, on the plan and with the co-operation of Prof. Jas. D. Dana" (New York, Wiley, 1877), that the principle which must govern the construction of mineral formulas,—*i.e.*, the unity of the mineral molecule,—and which I so strongly emphasized in the preface to the first edition, finds abundant recognition throughout. Not indeed everywhere, and not in the form of rational, but generally in that of empirical formulas: yet this latter form of stating the constituents of a mineral seems vastly preferable to that of separate compounds united by the sign plus (+). It cannot be doubted, either, that until we are more advanced in our knowledge of the conditions affecting the existence of the gaseous, the liquid, and more especially the solid molecule, the safest method of writing a mineral formula is the empirical. But who would shut his eyes to the lines of order which these rational formulas point out, imperfect though they be?

For his part, the presenter of these formulas does not regret the labor they have cost nor the manner in which they were printed. They have all been carefully revised, and some typographical errors corrected. A few rational formulas have been abandoned and others added. Some species printed in the first edition have been altogether suppressed in this, and several important species which were accidentally omitted there are here given. The corrections and alterations have been numerous and important, and it is hoped that by their aid the work will meet all the requirements which may be reasonably made of it. A table of elements, with their atomic weights and valences, according to the most recent investigators, forms a new feature in this book. By its aid the percentage composition of any mineral in the tables may be calculated in the absence of handbooks containing the records of actual analyses, and it is conveniently at hand for reference by those who may desire to establish a rational formula where the author has failed to do so.

Part of the translation of Prof. Weisbach's preface to his tables of 1866, prefixed to the first edition, has been omitted here, because of its inapplicability to this work; but the first page is retained, because it explains the object of the tables in the words of the inventor of this general scheme; and the title-page and headings to the first fourteen or fifteen pages, besides several places in the original introduction, have been changed, in order to make them represent more accurately the relation of the present book to its German prototype.

I am greatly indebted to Professors Cornwall, of Princeton, and Petty, of Ann Arbor, and to Messrs. Caswell, of Columbia College, New York, and Frenzel, of Freiberg, Saxony, and especially to the first, for valuable suggestions, the larger part of which I have adopted.

P. F., Jr.

Philadelphia, September, 1877.

MINERALS OF

I.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
† **Copper**	copper-red	copper-red	2.75	malleable
† **Niccolite**‡	light copper-red	brownish black	5.25	brittle
Breithauptite†	copper-red violet hue	red brown	5.5	brittle

II.

† **Sternbergite**‡	pinchbeck-brown bronze-yellow	black	1.5	malleable
† **Gold**	gold-yellow	gold-yellow	2.5	malleable
Electrum‡	yellowish white	yellowish white	2.5	malleable
† **Bornite**†	reddish pinchbeck-brown	greenish black	3.5	brittle
† **Millerite**†	speiss to bronze-yellow	black to bright	4	brittle

METALLIC LUSTRE.

Red.

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
isom.	.....	Cu (oc. with Ag, As, Sb, Bi, etc.)	G. 8.9.
hex.	.....	$*(Ni_2)^{v}As_2^{'''}$ (oc. with Fe, Co, Sb, and S)	G. 7.5.
hex.	.....	$*(Ni_2)^{v}Sb_2^{'''}$ (oc. with galena and tr. Fe)	G. 7.5.

Yellow.

orthrhm.	O	Ag,Fe_2,S_6	G. 4.2.
isom.	.....	Au (gen. with Ag and oc. tr. Cu, Fe, Par. Rh.)	G. 15.6 — 19.5.
isom.	.....	$xAu + yAg$	G. 12.5 — 15.5.
isom.	O in traces	$*(Cu_2)_3''(Fe_2)^{v}S_6''$	Fresh surfaces after few hours tarnishing red, after longer time bluish red, reddish blue, and blue. G. 5.
hex. R.	R. perf.	Ni″S″(tr. Fe and Cu)	Usually in capillary crystals, or radiating tufts. G. 5.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
+**Chalcopyrite**	brass-yellow	green black	4	sect. to brittle
Barnhardite§ (Homichlin)	bronze-yellow	grayish black	4	sect. to brittle
+**Pyrrhotite**	bronze-yellow	black	4.5	brittle
+**Marcasite**†	white speiss-yellow	black	6	brittle
+**Pyrite**	pale brass-yellow	black	6.5	brittle
Calaverite§	pale brass-yellow	.....	?	.....

III.

+**Mercury**†	tin-white	.....	liquid	.....
+**Bismuth**†	silver-white with reddish hue	gray	2.25	sect. to brittle
Tellurium†	tin-white	gray	2.5	brittle to sect.
Hessite‡	lead-gray to steel-gray	gray	2.5	malleable
+**Silver**	silver-white	silver-white	3	malleable
Amalgam†	silver-white	gray	3	brittle
+**Antimony**†	tin-white	gray	3	sect. to brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
tetrag.	O indistinct 2–i oc. "	$(Cu_2)''S_2''((Fe_2)^{v}''S_2'')$	G. 4.2.
tetrag.	.....	$(Cu_2)_2''S_4''((Fe_2)^{v}''S'')$	G. 4.5.
hex.	O perf. I less so	Fe_7S_8 [D]	In great part magnetic, frequently containing Ni. G. 4.5.
orthrhm.	I rather perf.	$Fe''S_2''$	G. 4.7.
isom.	O more or less distinct	$Fe''S_2''$	G. 5.
.....	.....	$(Au'''Te_2'')'–(Te_2''-Au''')'$	.....

White.

isom.	.....	Hg''(oft. with a little Ag)	BB volatile and condensing in drops. G. 13.5.
hex. (rhmbdrl)	O perf. 2,–2 less so.	Bi''' (tr. As, S, and Te)	G. 9.7.
hex.	I perf.	Te'' (with Fe and some Au)	G. 6.2.
orthrhm.	indistinct	$Ag_2'Te''$	G. 8.5, var. Petzite, iron-black,—brittle. G=9, —contains Gold.
isom.	.....	Ag (with some Cu or Au, and sometimes Pt, Sb, Bi, Hg)	G. 10.5.
isom.	.....	$Ag_2'(Hg_2)''$ [D]	G. 10.5—14.
hex. R.	O. h. perf. –½ indistinct	Sb (sometimes Ag, Fe, or As)	G. 6.6.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
Altaite‡	tin-to yellow-white	gray	3.25	sectile
✗**Domeykite**‡	tin-white to steel-gray	gray	3.25	brittle
✗**Whitneyite**‡	reddish white	reddish white	3.5	malleable
Dyscrasite‡	silver-white	gray	3.5	sectile
Algodonite‡	silver-white to steel-gray	silver-white	4	slightly malle.
Grünauite‡	tin-white to steel-gray.	gray	4.5	brittle
Palladium§	gray silver-white	gray	4.5	malleable
✝**Leucopyrite**†	gray tin-white	black	5	brittle
✝ **Smaltite** (Chloantite)	tin-white	black	5	brittle
✝ **Gersdorffite**†	tin-white	black	5	brittle
✝ **Linnæite**†	red silver-white	black	5.25	brittle
Danaite‡	red silver-white	black	5.5	brittle
✝ **Cobaltite**	red silver-white	gray	5.5	brittle
✝ **Arsenopyrite** (Mispickel)	tin-white	black	5.5	brittle
Ullmannite‡	tin-white	black	5.5	brittle
Plinian§ (V. of Mispickel)	tin-white	black	5.5	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
isom.	O distinct.	$Pb''Te''$	G. 8.1. Lustre very brilliant.
.....	.....	$*(Cu_2)_3''As_2'''$ [D]	G. 7.5.
.....	.....	$(Cu_2)_9,As_2$ [D] (?)	G. 8.5.
orthrhm.	O distinct.	$*Ag_5'Sb^v$ [D 9]	G. 9.5.
.....	.....	$(Cu_2)_6'',As_2'''$ [D] (?)	G. 7.62. NOTE.—If Cu = 80.89, As = 19.11 p. c., then formula $(Cu_2)_5''As_2^v$. Dana gives Cu = 83.50 As 16.50, from 3 analyses of Genth and 1 of Field.
isom.	octahedral	Ni, S, Bi, Fe, Cu, Pb, Co. (No formula deduced.)	.....
isom.	.....	Pd (with Pt and Ir)	G. ±11.5. BB infusible
orthrhm.	.....	$*Fe''As_2'$ (with 0.7 to 1.6 p. c. S)	G. 6.8.
isom.	octahedral	$*(Co,Fe,Ni,)''As_2'$ [D]	G. 6.8.
isom.	cub. (rather perf.)	$Ni''(S''As')_2'$	G. 6.
isom.	cub. (imp.)	Co_3S_4 (Co replaced by Ni or Cu)	G. ±4.9.
orthrhm.	prism.	$(Fe,Co)(S''As')_2'$ (?)	G. 6.
isom.	cub. (perf.)	$Co(S''As')_2'$ (?)	G. 6.
orthrhm.	I (seldom)	$Fe(S''As')_2'$ (?) (part of Fe occa. replaced by Co)	G. 6.
isom.	cub. (perf.)	$Ni(S(As,Sb)')_2'$ (?)	G. 6.3.
mcl.	P & M (dist.)	$Fe(S''As')_2'$ (?)	G. 6.3.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
Skutterudite‡	tin-white	black	5.75	brittle
Iridosmine‡	silver-white to gray	black	6	brittle
Iridium‡	silver-white	bright gray	6.75	malle. to sect.

IV.

+ **Molybdenite**	reddish lead-gray	gray or green	1.5	malleable
+ **Nagyagite‡**	black lead-gray to iron-black.	grayish black	1.5	malleable to sectile
+ **Lead§**	lead-gray	gray	1.5	malleable
+ **Sylvanite†**	light steel-gray	gray	1.75	sectile
White Tellurium‡	silver-white to speiss-yellow	gray	2	sectile
+ **Pyrolusite**	dark steel-gray to light iron-black	black	2	sect. to brittle
+ **Tetradymite†**	lead-gray	gray black	2	sect. to malle.
Jamesonite†	black lead-gray to steel-gray	gray black	2	sectile
Emplectite†	light steel-gray	gray black	2.5	sectile

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
isom.	cub.(distinct)	$*(Co_2)^{v}As_6'$ (with 1.5 Fe and tr. S)(?)	G. 6.7.
hex.	.....	$xIr + yOs$ (with Rd, Pt, Cu, Fe, Ru)	G. 19.3 — 21.12. BB infusible.
isom.	.....	Ir	G. 19.3 — 21.12. BB infusible.

Gray.

hex.	basal (eminent)	$*Mo'^{v}S_2''$	G. ±4.6. BB infusible. Gray streak on paper and unglazed porcelain. Green streak on glazed porcelain.
tetr.	basal (eminent)	$*Pb'^{v}Te_2''$. (Pb replaced by Au, Ag, Cu. Te by S)	G. 6.9.
isom.	.....	Pb	G. 11.44 when pure.
mcl.	i–$\bar{1}$ (distinct)	$*(Ag'Au''')Te_2''$ [D1] (Often with Sb and Pb)	G. 5.7 to 8.28.
mcl.	i–$\bar{1}$ (distinct)	$*(Ag'Au''')Te_2''$ [D1] (Often with Sb and Pb)	G. 5.7 to 8.28.
orthrhm.	I and i–i	$Mn'^{v}O_2''$ (with oc. Ba, Si, and H_2O)	BB infusible. G. 4.8.
hex.	basal (very perf.)	$*Bi_2'''Te_3''$ [D1] (Bi with some Fe and Te, often with some S)	G. 7.2 — 7.9.
orthrhm.	basal (highly perf.)	$*Pb_2''Sb_2'''S_5''$ (with Fe and tr. Cu and Zn)	G. 5.7.
orthrhm.	.....	$*(Cu_2)''(Bi'''S_2'')_2'$[D1]	G. 5.15.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
+ **Stibnite**	lead-gray	black	2.5	sectile
Freieslebenite‡	steel-gray to black lead-gray	gray black	2.5	sect. to brittle
+ **Argentite**	black lead-gray	gray black	2.5	malleable
+ **Bismuthinite**†	light steel-gray	black	2.5	sect. to brittle
+ **Clausthalite**‡	lead-gray	grayish black	2.5	sectile
Chalcostibite‡	lead-gray	grayish black	2.5	brittle to sect.
Naumannite‡	black lead-gray to iron-black	grayish black	2.5	malle. to sect.
Zinkenite‡	lead-gray	grayish black	2.5	sect. to brittle
+ **Galenite**	reddish lead-gray	grayish black	2.75	sectile
+ **Chalcocite**	black lead-gray	grayish black	2.75	sect. to brittle
Bournonite†	steel-gray to iron-black	grayish black	2.75	brittle to sect.
Light Polytelite§ (Freibergite) (V. Tetrahedrite)	lead-gray	grayish black	2.75	mild
+ **Boulangerite**†	lead-gray	grayish black	2.75	mild
Wittichenite‡	lead-gray to iron-black	grayish black	2.75	mild

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
orthrhm.	i–ĭ (highly perf.)	$Sb_2'''S_3''$	G. 4.5. Melts in candle flame.
mcl.	I (perf.)	$S_3Sb_2Ag_2Pb$ [D 1 & 3]	G. ± 6.2.
isom.	I (traces)	$Ag_2'S''$	G. 7.2.
orthrhm.	i–ĭ (perf.)	$Bi_2'''S_3''$	G. 6.4.
isom.	cubic.	Pb″Se″ (with Fe and Co)	G. 7.6 to 8.8. BB decrepitates in closed tube.
orthrhm.	i–ĭ(very perf.)	$*(Cu_2)''(Sb'''S_2'')_2'$	G. 4.7. BB decrepitates in closed tube, and gives subl. of Sb_2S_3, which, cold, is red.
isom.	cubic (perf.)	$Ag_2'Se''$ (always contains Pb)	G. 8.
orthrhm.	?	$*Pb''(Sb'''S_2'')_2'$	G. 5.3. BB decrepitates in closed tube. On charcoal coat white at edge, and near assay yellow. R.F. yields button of Pb.
isom.	cubic (perf.)	Pb″S″	G. 7.5.
orthrhm.	.....	$(Cu_2)''S''$	G. 5.7. BB yields nothing vol. in closed tube. SO_2 in open tube. R.F. with soda metallic Cu.
orthrhm.	.....	$*Pb_2''(Cu_2)''(Sb'''S_3'')_2'''$ [D 1]	G. 5.8.
crystalline	.....	Contains Pb, Ag_2, Fe, Zn, S, and Sb	G. 5.4.
crystalline	.....	$*Pb_3''(Sb'''S_3'')_2'''$ [D]	G. 5.8.
crystalline	.....	$*(Cu_2'')_2''Bi_2'''S_5''$	G. 5.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
Tiemannite‡	lead-gray	grayish black	2.75	sect. to brittle
+ **Stephanite†** (Brittle silver ore)	black lead-gray to iron-black	grayish black	2.75	sectile
Berthierite†	lead-gray to dark steel-gray	grayish black	3	brittle
Dufrenoysite‡	blackish lead-gray	reddish brown	3	very brittle
Sartorite‡ (Scleroclase)	light lead-gray	reddish brown	3	very brittle
+ **Miargyrite†**	steel-gray to iron-black	dark cherry-red	3	sectile
+ **Arsenic†**	whitish	gray	3.25	brittle to sect.
+ **Tetrahedrite** (Antimonial) (Common variety)	dark steel-gray lead-gray iron-black	black in part, inclining to cherry-red	3.5	brittle
Tetrahedrite (Arsenical) (Tennantite)	dark steel-gray	dark red gray to dark cherry-red	3.5	brittle
Tetrahedrite† (Mercurial) (Hermesite)	steel-gray	black	3.5	brittle to sect.
* **Stannite†**	steel-gray to gray	black	3.5	brittle
+ **Gersdorffite†**	lead-gray to light steel-gray	black	5	brittle
+ **Smaltite**	steel-gray to blue gray	black	5	brittle
Platinum†	platina-gray	gray	5.75	malleable
— **Iron§**	light steel-gray	gray	6	malleable

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
crystalline	.....	Hg″Se″	G. 7.2. BB volatile.
orthrhm.	.....	$*Ag_5'(Sb^{v}S_5'')^{v}$ [D]	G. 6.2.
crystalline	in one direction	$*Fe''(S_2''Sb')_2'$ [D]	G. 4.1.
orthrhm.	O (perf.)	Pb,As,S_3	G. 5.5.
orthrhm.	O (distinct)	$Pb''(As'''S_2'')_2'$ [D]	G. 5.4.
mcl.	i–i (imperf.)	$*Ag'(Sb'''S_2'')'$ [D]	G. 5.3.
hex. (rhdrl.)	O (imperf.)	As (often with Sb, Fe, Ag, Au, Bi)	G. 5.9. Fresh surface of fracture, tarnishes in short time to grayish black.
isom.	.....	$*(Cu_2)_2''(Sb_2^{v}S_7'')^{iv}$	G. 4.5.—5.1. BB volatile without melting.
isom.	.....	Sb partly replaced by As. Cu often replaced by Fe	G. ± 4.7.
isom.	.....	Contains Cu_2,Fe,Zn,Ag, and 0.5 to 17.3 p. c. Hg, Sb_2, As_2, and Bi_2	G. ± 4.7.
tetr. (?)	.....	$Sn,(Cu_2)_2'',S_7,Fe_2$[D1&2]	G. 4.4.
isom.	O (rather perf.)	$Ni(S''As')_2'$	G. 6.
isom.	.....	$(Co,Fe,Ni)''As_2'$ (?)	G. 6.7.
isom.	.....	Pt (containing Fe, Ir, Os, etc.)	G. 16—19. Occasionally magneto-polar.
isom.	O (partly distinct)	Fe (containing Ni, Co, Si, Mg, etc.)	G. 7.5. Magnetic. BB infusible. Always meteoric.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
Polianite† (Var. Pyrolusite)	light steel-gray	black	6	brittle
† **Hematite**	steel-gray to iron-black	cherry-red brown red black red	6.5	brittle

V.

† **Graphite**	iron-black	black	< 1	sectile
† **Pyrolusite**	light iron-black to dark steel-black	black	2	sect. to brittle
Acanthite†	iron-black	gray black	2.5	malleable
Polybasite†	iron-black	black	2.5	sect. to brittle
Naumannite‡	iron-black to black lead-gray	grayish black	2.5	sect. to malle.
Stromeyerite‡	iron-black	gray black (shining)	2.75	sect. to malle.
Wittichenite‡	iron-black to lead-gray	gray black	2.75	sectile
† **Stephanite**†	iron-black to black lead-gray	gray black	2.75	mild
Bournonite†	iron-black to steel-gray	gray black	2.75	brittle to mild

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
orthrhm.	I (distinct) ĭĭ	$Mn'^{V}O_2''$ (with Ba, Si, and H_2O)	G. 4.8. BB infusible.
hex. (rhdrl.)	R (seldom distinct)	$(Fe_2)'''O_3''$	G. 4.8. BB infusible. Sometimes magnetic and magneto-polar.

Black.

hex.	O (perf.)	C (with 6 to 47 p. c. impurities, chiefly Al_2O_3, SiO_2, Fe_2O_3, MgO, and CaO)	Greasy feel. BB burns without melting. Soils white paper.
orthrhm.	I and ĭĭ	$Mn'^{V}O_2''$ (with Ba, Si, and H_2O)	Infusible. Soils white paper. G. 4.8.
orthrhm.	.....	$Ag_2'S''$	G. 7.2. BB yields SO_2, and gives silver button with Soda.
hex.	O (distinct.)	*Contains Cu, Ag, Sb, As, and S	G. 6.2.
isom.	O (perf.)	$(Ag_2',Pb'')Se''$ (pure, $Ag_2'Se''$)	G. 8.
orthrhm.	.....	$*(Ag_2,(Cu_2'')'')S_2''$ [D2]	G. 6.2.
crystalline	.....	$(Bi'''S_2)'(Cu_2)_2''(Bi'''S_2'')'''$ [D7], or $S'' = Bi''' - S'' - (Cu_2)_2'' \equiv S_3'' \equiv Bi'''$	G. 5.
orthrhm.	$\frac{2-i}{ĭĭ}$ imperf.	$*Ag_5'Sb^{V}S_5''$ (nearly)	G. 6.2.
orthrhm.	ĭĭ (imperf.) ĭĭ O (less dist.)	$*Pb_2''(Cu_2)''(Sb'''S_3'')_2'''$ [D1]	G. 5.8.

NAME.	COLOR.	STREAK.	HARD'SS	TENACITY.
+**Enargite**‡	iron-black	black	3	brittle
+ **Miargyrite**†	iron-black to steel-gray	dark cherry-red	3	sectile
+ **Tetrahedrite**‡ (Schwarzerz) (Schwatzite)	iron-black	brown black	3.75	brittle
+ **Manganite**†	iron-black	brown	4.25	sect. to brittle
+ **Melaconite**† (Tenorite)	iron-black	black	5	brittle to sect.
† **Hausmannite**†	iron-black	brown sometimes reddish	5.5	brittle
+ **Magnetite**	iron-black	black	5.5	brittle
+ **Menaccanite**†	iron-black	black red brown brown red	6	brittle
+ **Chromite**†	iron-black	dark brown	6	brittle
+ **Franklinite**†	iron-black	brown	6.25	brittle
+ **Hematite**	iron-black to steel-gray	cherry-red brown red black red	6.5	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
orthrhm.	I (perfect) ii (distinct) ii (distinct) O (indistinct)	$*(Cu_2)_2''(As^{V}S_4'')_2'''$ [D]	G. 4.4
mcl.	.....	$Ag'(Sb'''S_2'')'$	G. 5.2.
isom.	.....	Contains Cu, Fe, Zn, Ag, and 0.5 to 17.3 p.c. Hg, Sb, As, Bi	G. 4.7.
orthrhm.	ii (very perf.) I (perfect)	$H_2'(Mn_2)^{V'}O_4''$	BB infusible. G. 4.3.
isom. orthrhm.	.....	$Cu''O''$	G. 6. Usually in scales.
tetrag.	O (nearly perf.)	$*Mn''(Mn_2)^{V'}O_4''$ or Mn_3O_4	BB infusible. G. 4.7.
isom.	O(seldom dis.)	$*Fe''(Fe_2)^{V'}O_4''$ or Fe_3O_4	G. ± 5. Strongly magnetic. BB infusible.
hex. (rhmbdrl)	.....	$Fe''(Ti'^{V}O_3)''$ mixed with xFe_2O_3	BB infusible. Partly magnetic. G. 4.7.
isom.	.....	$Fe''(Cr^{V'}O_4)''$ (contains Mg, Fe, Cr, Al, and Fe)	G. 4.3. Usually slightly magnetic. BB infusible. P. c. Cr_2O_3 varies from 39.51 to 63.38.
isom.	.....	$*(Fe'',Zn'',Mn'')(Fe_2,Mn_2)^{V'}O_4''$	G. 5. BB infusible. Slightly magnetic.
hex. (rhmbdrl)	R (seldom distinct)	$(Fe_2)^{V'}O_3''$	BB infusible. Sometimes magnetic and magnetopolar. G. 4.8.

MINERALS OF SUB-METALLIC

OF BLACK, BROWN, RED,

I. Of Black Streak

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Asbolite†	slightly resinous	bluish black	bluish black	1.25	sect. to malle.
Asphaltum†	resinous	pitch-black	black to brown	1.25	sectile
Covellite†	adamantine to resinous	indigo-blue	black	1.5–2	sect. to brittle
Bituminous Coal	resinous to vitreous	black partly brown	black	2.5	sect. to brittle
Anthracite	half-metal.	black	black	2.3–2.6	brittle
Lampadite‡	resinous	bluish black	bluish black	3.2	brittle to sect.
Sphalerite† (In part)	vitreous	black	brownish black	4	brittle
Uraninite†	resinous partly metallic	black	black to brown	5.5	brittle
Ilvaite‡	resinous to semi-metal.	black	greenish black	5.75	brittle
Columbite‡	sub-metal.	black	brownish black	6	brittle

AND NON-METALLIC LUSTRE

YELLOW, GREEN, OR BLUE STREAK.

(all Opaque).

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
amorphous	conchoidal to plane	Contains Mn, Fe, Co, Cu, Ba, O, H_2O	G. ± 3.5. Variety of Wad.
amorphous	conchoidal	C 75, H 10, O 15	G. ± 1.5. Sticky. Ignitible by candle-flame, and burning with light.
hexagonal	basal and pyramidal	Cu″S″	G. 4.
amorphous	conchoidal to plane	C, H, O with ash	G. 1.4 — 1.6. Ignitible by a candle, and burning with light.
amorphous	conchoidal	C with little H, O, etc.	G. ± 1.7.
amorphous	conchoidal	Mn, Fe, Ba, Co, Cu, O, H_2O	G. ± 3.5. Variety of Wad.
isom.	I (highly perfect)	Zn″S″	G. 4. BB fusible with difficulty.
amorphous	conchoidal to uneven	$U''(U_2)^{v}O_4''$	G. 6.4 — 8.
orthrhm.	ii	Si, Al_2, Fe, Mn, Cu, H_2O	G. ± 4.
orthrhm.	ii (?)	Contains Fe, Mn, Cb, Ta	G. ± 6. BB infusible.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
† **Psilomelane**	sub-metal. to non-metallic, lustre of streak greater	bluish black	black, in part brown	6.25	brittle
†**Braunite**†	sub-metal.	black	black	6.25	brittle

II. Of

Dopplerite‡	vitreous to resinous	brownish black, reddish br. by trans. light	dark wood-brown	<1	ductile
† **Bog Manganese** (Wad)	glistening	black brown to blue black	black brown	1.25	sectile
Idrialite‡	resinous, increasing in streak.	impure brown black	brown black	1.25	sectile
Ozocerite‡	resinous	brown	yellow brown	1.25	ductile
Chloropal‡ (Fettbol)	resinous	liver-brown	liver-brown	1.75	sectile
Asphaltum‡ (Pianzite)	resinous	black brown	yellow brown	1.75	sectile
Pyroretinite‡	feebly resinous	black brown	dark wood-brown	2	very brittle
Hepatic Cinnabar†	resinous to metalloid	brown red, partly lead-gray	red brown	2.25	sect. to brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
amorphous	fracture conchoidal to uneven	Contains Mn, Ba, and H_2O	G. $\pm$ 4.
tetrag.	fracture uneven	$(Mn_2)^{v}O_3''$. Contains also some $Mn''(Si^{v}O_3'')''$	G. $\pm$ 4.7.

Brown Streak.

amorphous	fracture conchoidal	Acid Hydrocarbon	G. 1.089. Inflammable.
amorphous	fracture uneven	Manganese Hydrate with Si, Al, Ba, and many other impurities	G. $\pm$ 3.7. Opaque.
amorphous	fracture uneven	Simple Hydrocarbon mixed with cinnabar, clay, and gypsum	Opaque. Greasy to the touch. Inflammable. Partly volatile.
amorphous	fracture conchoidal to splintery	Simple Hydrocarbon	Aromatic odor. Sticky. Inflammable with bright flame.
amorphous	fracture conchoidal	Hydro-ferrous Silicate with some Mg and Al	Opaque. Greasy feel. G. 1.7.
amorphous	fracture conchoidal	C, H, O, N, and ash	Inflammable.
amorphous	fracture conchoidal	Simple Hydrocarbon	Inflammable.
amorphous	.....	Impure Cinnabar, chiefly $Hg''S''$ mixed with the white hydrocarbon Idrialite	G. $\pm$ 8.5. Inflammable.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Brown Coal	resinous	brown to black	brown, partly black	2.5	sect., partly brittle
Gillingite‡	vitreous, partly resinous	brown to brown black	red brown	3.5	brittle
✝ **Chrysocolla**	vitreous to resinous	brown to black (impure)	red brown	3.5	brittle
Lepidocrocite‡ (Fibrous scaly Göthite)	mother-of-pearl	yellow-brown to red	yellow-brown to red	3.75	brittle
✝ **Siderite**	vitreous O pearly	pale yellow yellow-brown	light brown	4	brittle
✝ **Sphalerite** (Zinc Blende)	vitreous to adamantine	black to brown	black brown pink brown light brown	4	brittle
Needle Ironstone (Radial acicular Göthite)	adamantine	black brown to pink brown	yellow-brown	4.5	brittle
✝ **Limonite** (Bog Ore)	resinous to vitreous	pitch-black	yellow-brown, partly red	4.5	brittle
Wolframite†	sub-metallic and adamantine	black	red brown black brown	5	brittle
✝ **Limonite†** (Stilpnosiderite)	sub-metallic to resinous	pitch-black	yellow brown	5.25	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
amorphous	fracture conchoidal to uneven	C, H, O, N, S, and ash	G. ± 1.4. Opaque. Inflammable in the candle-flame, and burning with light.
amorphous	fracture conchoidal	Hydrous Silicate of Fe, Al, and Mn, with occasional Ca and Mg	G. ± 3. Opaque. In closed tube yields much water. BB fuses to black magnetic globule. Decomposed by HCl.
amorphous	fracture conchoidal	$Cu''(Si'^{V}O_3'')'' + 1, 2, or 3(H_2O)$, with Si, Fe, Mn, etc., as impurities	G. 2.1. Opaque. Closed tube blackens and gives water. BB decrepitates, and colors flame green. Is infusible. Frequent as cap rock.
crystalline	.....	$H_2'(Fe_2)^{V}O_4''$ (generally contains Mn)	G. 4.3. Opaque. Closed tube gives off water and converted to sesquioxide.
hexagonal	R (imperfect)	$Fe''(CO_3)''$ contains often Mg, Mn, and Ca	G. 3.8. In closed tube decrepitates and becomes magnetic. BB blackens and fuses at 4.5. By exposure it darkens.
isometric	I (perf.)	Zn″S″ (impurities Fe and Ca)	G. 4. BB fusible with difficulty.
orthorhombic	ii	$H_2'(Fe_2)^{V}O_4''$	G. 4.3. (See *Lepidocrocite* above.)
amorphous	fracture conchoidal	$((Fe_2)_2^{V}O_3'')^{V}(OH)_6'$ with Mn and P sometimes	G. 3.7. Opaque. BB (see *Lepidocrocite*).
orthorhombic	ii (perf.)	$(Fe'',Mn'')(W^{V}O_4)''$	G. ± 7.2. BB fuses easily to magnetic button which has a crystalline surface. With microcosmic salt red yellow glass while hot. On charcoal with tin on cooling green.
amorphous	fracture conchoidal	$((Fe_2)_2^{V}O_3'')^{V}(OH)_6'$ with sometimes Mn and P	G. 3.7. Opaque. (See above.)

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
† **Limonite** (Brown clay iron-stone)	partly vitreous	brown	yellow brown to liver-brown	5.25	brittle
† **Limonite** (Common)	resinous and in part satin	brown	yellow brown	5.5	brittle
† **Psilomelane**†	non-metallic to submetallic	black	black brown	6.25	brittle
† **Rutile**†	metalloid adamantine	black brown	light brown, partly yellow	6.25	brittle
† **Cassiterite**†	impure adamantine	black brown	light gray brown	6.5	brittle

III. Of

Kermesite‡	adamantine	cherry-red	brownish red	1.5	sectile
† **Cinnabar**	adamantine	cochineal-red	scarlet	2–2.5	sectile
Pyrostilpnite‡	pearly adamantine	hyacinth-red	hyacinth-red	2–2.5	sectile
Erythrite†	adamantine il–mother-of-pearl	crimson- and peach-red, sometimes pearl- or green gray	paler than color dry powder deep lavender-blue.	1.5–2.5	sect. to brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
amorphous	.....	$((Fe_2)_2{}^{v\prime}O_3'')^{v\prime}(OH)_6'$	G. 3.7. Opaque. (See last page.)
crystalline	.....	$((Fe_2)_2{}^{v\prime}O_3'')^{v\prime}(OH)_6'$	G. 3.7. (See preceding.)
amorphous	fracture conchoidal to uneven	$(Ba'',Mn'')\ (Mn_2)^{v\prime}O_4''$ with $H_2'(Mn_2)^{v\prime}O_4$ (contains also frequently Cu, Si, Fe, Al, Na, and K)	G. 4. Opaque. BB infusible.
tetragonal	I (perf.) ii (observable)	$Ti'^{v}O_2''$	G. 4.2. Opaque. BB infusible. With microcosmic salt a colorless bead, which, in R.F., becomes violet on cooling.
tetragonal	I (perf.) ii (observable)	$Sn'^{v}O_2''$	G. 6.8. Opaque. BB infusible. On charcoal with soda button of metallic tin and white coat.

Red Streak.

monoclinic	O	$S''=Sb'''-O''-Sb'''=S''$ [D 1]. $(Sb'''S'')_2'O''$	G. 4.5. Thin leaves, flexible. Closed tube blackens, and gives first white and then dark-red sublimate.
hexagonal (rhombohedr'l)	I (very perfect)	$Hg''S''$ or Hg_2S_2	G. 9. BB volatile.
monoclinic	ii	62.3 p. c. Ag with S and Sb	G. 4.25.
monoclinic	ii (highly perfect)	$*Co_3''(As^{v}O_4'')_2''' + 8(H_2O)$ [D]. Co partly replaced by Fe, Ca, and Ni	G. $=\pm 3$. BB charcoal: arsenic odor. Borax: cobalt glass.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Proustite	adamantine	cochineal-red	auroral to scarlet	2.5 –2.75	sect. to brittle
Pyrargyrite	metallic adamantine	black, sometimes approaching cochineal-red	cochineal-red	2–3	sect. to brittle
Chrysocolla	resinous or vitreous to earthy	brown to brownish black. When pure, mountain-green to sky-blue	brownish red. When pure, white	2–4	partly sectile, generally brittle
Zincite†	sub-adamantine	deep red to orange yellow	orange yellow	4	brittle
Cuprite†	adamantine	dark red	brownish red	4	brittle
Hauerite‡	metallic adamantine	dark reddish brown	brownish red	4	brittle
Hematite	earthy to half-metallic	dark red to steel-gray	blood-red	3–6.5	brittle
Turgite†	satin-like in direction of fibres	reddish black to dark red	reddish black to dark red	5.5	brittle to earthy
Ferruginous Quartz	vitreous	blood-red to brownish red	flesh-red to blood-red	7	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
hexagonal (rhombohedr'l)	R (sometimes)	$*Ag_3'(As'''S_3'')'''$ [D]	G. 5.42. BB charcoal odor of SO_2 and As. With soda, silver button.
hexagonal (rhombohedr'l)	R (imperfect)	$*Ag_3'(Sb'''S_3'')'''$ [D]	G. ±5.8. BB charcoal fuses with spirting to globule. Coats coal white. With soda, button of silver.
crypto-crystalline	.....	$Cu''(Si^{IV}O_3'')'' + 1, 2, \text{or } 3(H_2O)$	G. 2. In closed tube yields water. BB decrepitates and colors flame green. With fluxes, reaction for copper.
hexagonal	O (eminent) ii(sometimes)	$Zn''O''$	G. ±5.5. BB infusible.
isometric	1	$(Cu_2)''O''$	G. ±6. BB colors flame green; moistened with HCl, blue.
isometric	O (imperfect)	$Mn'^{V}S_2''$	G. 3.4. BB infusible.
crystalline	.....	$(Fe_2)^{V'}O_3''$	G. ±5. BB infusible. Charcoal R. F. becomes magnetic.
.....	.....	$((Fe_2)_2{}^{V'}O_5'')''(OH)_2'$	G. ±3.67. Heated in closed tube decrepitates. Otherwise like limonite.
hexagonal	.....	$Si^{IV}O_2''$, with red or yellow iron oxide	G. ±2.6. BB infusible.

IV. Of

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
† **Yellow Ochre**‡ (Xanthosiderite) (Limnite)	earthy	ochre-yellow	ochre-yellow	1	sectile
Uraconite‡	lustreless, or slightly shining in spangles. Silky to mother-of-pearl	sulphur- to lemon-yellow	sulphur- to lemon-yellow	1	sectile
Torbernite‡ (Uranite)	O pearly, otherwise vitreous	sulphur-yellow to green	sulphur-yellow	2	sectile
Humboldtine‡ (Oxalite)	lustreless to slightly spangled	ochre-yellow to straw-yellow	straw-yellow	2	sectile
† **Realgar**†	resinous partly adamantine	auroral red	orange-yellow	2	sect. to brittle
† **Orpiment**†	pearly on cleavage surfaces, elsewhere resinous	lemon-yellow	lemon-yellow	2	sectile
† **Sulphur**	resinous	sulphur-yellow to gray brown and red	sulphur- to reddish or greenish yellow	2	sectile
Autunite†	O pearly, otherwise sub-adamantine.	citron- to sulphur-yellow.	yellowish	2.25	sectile

Yellow Streak.

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
amorphous	fracture earthy	$((Fe_2)_2{}^{v\prime}O_3{}'')^{v\prime}(OH)_6{}'+$ org. matter and $x(H_2O)$	G. 3.7. Slightly greasy feel. Adheres to tongue. BB infusible.
crystalline	.....	Contains S, U, Fe, Cu, Ca, O, H_2O	BB infusible.
tetragonal	O (perfect)	$*(U,''Cu'')(P^vO_5'')^v+ 8(H_2O)$ (?)	G. 3.5. In closed tube yields water. In forceps fuses to blackish mass and colors flame green. With microcosmic salt fuses to green bead, and with tin on coal cools to opaque red.
crystalline	.....	$*(Fe''(C_2{}^{v}O_4'')'')_2+ 3(H_2O)$	G. ± 2.2. BB infusible. Closed tube turns black, loses water, and becomes magnetic.
monoclinic	ii O (rather perfect)	$*S''=As'''-As'''=S''$ or $(As_2'''){}^{v}S_2''$ (?)	G. 3.4 — 3.6. Combustible. BB burns with blue flame and arsenic odor. In closed tube, red sublimate.
orthorhombic	ii (perfect)	$*As_2'''S_3''$	G. 3.48. In closed tube, yellow sublimate, otherwise like realgar.
orthorhombic	I 1 (imperfect)	S	G. 2.072. BB burns with a blue flame.
orthorhombic	O eminent	$((U_2)^{v\prime}O_2'')_2''Ca'')^{v\prime}$- $(P^vO_4'')_2''' + 8(H_2O)$	G. ± 3.12. In closed tube yields water. BB fuses at 2.5 to a blackened mass.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Xanthaconite‡	adamantine to pearly	dull red to clove-brown	yellow	2.5	sect. to brittle
Crocoite‡	vitreous to adamantine	hyacinth to auroral red	orange-yellow	2.5	sectile
Gummite‡	greasy	reddish yellow, reddish brown	yellow	2.5–3	sect. to brittle
Pharmacosiderite†	adamantine to greasy	olive-green to yellowish brown	green brown yellow	2.5	rather sectile
Limonite†	lustrous in points to earthy	light lemon-yellow	light lemon-yellow	3	sect. to slightly brittle
Pittieite‡	vitreous to greasy	yellowish and reddish brown	ochre-yellow	3	brittle
Diadochite‡	resinous to vitreous	yellow to yellow brown	.....	3	fragile
Borickite§ (Delvauxene)	weak waxy	brick-red to chestnut-brown	brownish yellow	3	brittle to sect.
Dechenite‡	greasy	deep red to yellowish red	orange- to ochre-yellow	3.25	brittle
Greenockite†	adamantine to greasy	honey-yellow	pomegranate-yellow	3.25	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
hexagonal (rhombohedr'l)	R and O	$*Ag_8'(As'''S_8'')'''$	G. 5.1. (See *Proustite.*)
monoclinic	I (tolerably distinct)	$*Pb''(Cr^{V}O_4'')''$	G. ±6. In closed tube blackens. On coal, is reduced to metallic lead with deflagration.
amorphous	fracture conchoidal to uneven	$(U_2O_3,Fe_2O_3)3H_2O$	G. ±4.1.
isometric	O (imperfect)	$*(Fe_2)_4^{V}(As_6^{V}O_{21}'')^{XXV} + 16(H_2O)$	G. ±3. Pyroelectric. *Para-arsenate.*
crystalline	fracture conchoidal to uneven	$((Fe_2)_2^{V}O_3'')^{V}(OH)_6'$	G. ±3.6.
amorphous	fracture conchoidal	$*(Fe_2)_2, As, Sb, O_{14} + 15(H_2O)$	G. 2.3.
.....	fracture conchoidal	$*(Fe_2)_2, P_4, S_2, O_{21} + 32(H_2O)$	G. 2. BB yields much water in closed tube. Swells up and becomes opaque yellow. In forceps swells up and falls to powder. Carefully heated fuses to gray-black slag.
amorphous	fracture on *large* surfaces conchoidal, on *small* surfaces earthy	Hydrated Ferro-calcium Phosphate	Opaque. G. 2.7.
crypt. cryst.	.....	Plumbo-zincic Vanadate	G. ±5. BB fuses easily without decrepitation to yellow glass.
hexagonal	I (distinct) O (imperfect)	Cd''S''	G. 4.8. Nearly transparent. Strong double refraction. Veined parallel to axis. BB gives SO_2 on coal and brown-red coat. Closed tube, carmine-color, fading to original color on cooling.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Eliasite‡	waxy to vitreous	dark reddish brown	wax to pomegranate-yellow	3.5	brittle
Cacoxenite‡	silky	ochre- to lemon-yellow (stains brown)	straw-yellow	3.5	brittle
Beudantite§	vitreous	olive-green	greenish yellow	3.5	brittle to sect.
Voltzite‡	greasy	yellow brown	pale yellow	3.5	brittle
Pyromorphite† (Wheatley Mine)	resinous to vitreous	yellow	pale yellow	3.5	brittle
† **Sphalerite** or **Zinc Blende**	adamantine	brown to reddish brown	straw-yellow Isabella-yellow, partly brownish	3.75	brittle
Lepidocrocite‡	mother-of-pearl	yellow brown to red	brownish yellow	3.75	brittle
† **Zincite**†	sub-adamantine	orange yellow	orange yellow	4	brittle
Palagonite‡	vitreous to greasy	yellow brown	yellow	4.5	brittle
† **Limonite**	greasy to vitreous, also silky	brown	brown yellow to ochre-yellow	5.5	brittle
Basaltic Hornblende‡ (Pargasite ?)	vitreous	brown black to pitch-black	Isabella-yellow to ochre-yellow	5.5	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
amorphous	fracture uneven to conchoidal	Contains U, Fe, Ca, Mg, Pb, Si, P, and 10.6 p. c. H_2O. U_2O_3 61–68 p. c. [D]	G. ± 4.5. Analogous to Xanthosiderite.
crystalline	.....	$(Fe_2^{V'}, Al_2^{V'})(P^VO_4'')_2''' + 12(H_2O)$ (contains F, Ca, and Si)	G. ± 3.4. BB closed tube yields water. Fusible on edges to black slag. Colors outer flame bluish green.
hexagonal (rhombohedr'l)	.....	Iron and Lead, phosphate and sulphate, containing Cu, As, and 8 to 12 p. c. H_2O	G. ± 4.2.
amorphous	fracture conchoidal	Mixed Sulphide and Oxide of Zinc. Contains Fe_2O_3 1 p. c., and tr. of resinous sub.	G. ± 3.7. BB very hard to fuse. BB like Sphalerite.
hexagonal	.....	$Pb_3''(P^VO_4'')_2'''$ with $PbCl_2$, $CaCl_2$, CaF_2	G. 6.5 to 7.1. In closed tube white sublimate. Fuses easily, and cooling takes polyhedral form.
isometric	I	$Zn''S''$ (contains often Fe and Cd, Cu, Sb, and Mn)	G. 4. Very hard to fuse. BB open tube, SO_2. On coal, coating of Zn and sometimes of Cd.
crystalline	.....	$H_2'Fe_2^{V''}O_4''$ (contains sometimes Mn, Si, Cu, and Pb)	G. ± 4.2. Opaque. Scaly fibrous variety of Göthite.
hexagonal	O eminent ii sometimes	$Zn''O''$	G. ± 5.5. BB infusible.
amorphous	fracture conchoidal and splintery	Mixed Silicates of R'' and $(R_2)^{V''} + H_2O$. R'' = Mg, Ca, K_2 and Na_2, $R_2^{V'}$ = Al_2 and Fe_2	G. ± 2.5.
crystalline	.....	$((Fe_2)_2^{V''}O_3'')^{V''}(OH)_6'$	G. ± 3.7. Opaque.
monoclinic	I (highly perfect)	$(Mg_3''Fe'')(Si^{V''}O_3'')_4''$ (contains Al, Ca, and F)	G. ± 3.1.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY
† **Cassiterite**	adamantine, slightly metallic	brown to black	Isabella-yellow	6.5	brittle
Ferruginous Quartz	vitreous	ochre-yellow to brown	light ochre-yellow	7	brittle

V. Of

Chloropal‡	waxy	greenfinch-green	greenfinch- to sulphur-yellow	1	malle. to sect.
† **Glauconite**‡	.....	olive-green blackish gr. yellowish gr. grayish gr.	like color	1.5	sectile
Lillite§	.....	blackish green	dark gray green	2	.....
Ehlite‡	common, partly mother-of-pearl	verdigris-green	like color	2	.....
Torbernite†	common on O, mother-of-pearl	emerald-gr. verdigris-gr. apple-green	apple-green	2.25	brittle to sect.
Conarite§	common, partly mother-of-pearl	greenfinch-green to pistachio-gr.	finch-green	2.25	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
tetrag.	I and ii (hardly distinct)	$Sn'^{V}O_2''$ (contains Si, Mn, and Ta)	G. ± 6.8. Opaque. BB infusible. Coal with soda metallic tin.
hexagonal	.....	$Si'^{V}O_2''$ (inclosing yellow or red oxide of iron)	G. 2.7. BB infusible. Borax dissolves slowly to clear glass-green when hot. Melts with soda with intumescence.

Green Streak.

amorphous	fracture on large surfaces conchoidal to uneven, on small surfaces splintery	Mixed Limonite and Ferrous Silicate, with Water.	G. ± 1.8. Closed tube yields water. BB infusible, but turns black, and becomes magnetic. Completely decomposed by HCl with separation of pulverulent SiO_2.
amorphous	large surfaces uneven, small surfaces earthy	Hydrous Silicate of K and Fe. Contains Al, Ca, Mg, Na, and 4.5 to 6.4 p. c. H_2O	G. ± 2.3. Opaque. Slightly greasy feel. Feebly adhesive to tongue.
amorphous	.....	Ferrous Silicate, Calcium Carbonate, Ferric Hydrate, Ferric Sulphide, and Water	G. ± 3. Chalky to the touch.
crystalline	perfect in one direction	$*Cu_5''(P^{V}O_5'')_3^{V} + 3(H_2O)$ (?) [D]	G. ± 4.1.
tetrag.	basal highly perfect	$*(U_4''Cu'')(P^{V}O_5'')_2^{V} + 8(H_2O)$ (?)	G. ± 3.5.
crystalline	perfect in one direction	$(Ni''(Si'^{V}O_3'')'')_2 + 3(H_2O)$ (contains Al, Fe, Co, P, As, S, and 11 p. c. H_2O)	G. ± 2.5. In thin lamellæ. Translucent. Fragile.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Röttisite‡ (Genthite)	resinous feeble to lustreless	apple-green to emerald-green	apple-green	2.25	sectile
Johannite‡	vitreous	emerald-gr. grass-green apple-green	light grass-green	2.25	sect. to brittle
Annabergite‡	.....	apple-green	light apple-green	2.25	sect. to brittle
+Ripidolite†	of cleavage face somewhat pearly	deep grass-green to olive-green	gray green to uncolored	2.5	sectile
Tyrolite‡	O pearly	verdigris-green	verdigris-gr. to sky-blue	2.5	sectile
Chalcophyllite‡	O pearly	emerald- to verdigris-green	same as color	2.5	brittle
Cronstedtite‡	brilliantly vitreous	raven-black	blackish green	2.5	brittle
Fuchsite‡ (Muscovite)	O pearly	yellowish to dark olive-green	bright green	2.5	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
.....	fracture conchoidal	Hydrous Silicate of Ni and Mg with Fe and Ca	G. 2.4. Sometimes so soft as to be polished by the nail. Closed tube blackens and gives water.
monoclinic	I	Uranium and Copper Sulphate with water and tr. Fe	G. 3.19. Soluble in water. Taste bitter. At low heat in tube unchanged. BB gives SO_2 and water. Precipitated from solution yellowish green by alkalies.
crystalline monoclinic)(?)	.....	$*Ni_3''(As^vO_4'')_2''' + 8(H_2O)$	G. (?). BB fuses easily with arsenic odor, and yields metallic button, which, with borax, gives first blue cobalt glass, and later violet to reddish brown of Ni.
monoclinic	O (eminent)	Hydrous Al and Mg Silicate with sometimes Cr and Fe	G. $\pm$ 2.7. BB yields water. In plat. forceps whitens, and fuses with difficulty on edges.
orthorhombic	O (perf.)	$*Cu_5''(As^vO_5'')_2^v + 9(H_2O)$	G. 3. In closed tube decrepitates and yields much water. Fuses on coal with arsenic odor. R.F. globules of copper.
hexagonal (rhombohedr'l)	O (highly perfect)	$*(Cu_3''O_3'')^x(As^vO_5'')_2^v + 12(H_2O)$	G. $\pm$ 2.5. In closed tube decrepitates and yields much water. Soluble in H,NO_3 and H_5NO.
hexagonal (rhombohedr'l)	O (highly perfect)	Contains Si, Fe, Mg, Mn, and H_2O	G. $\pm$ 3.3. BB froths and fuses on edges. Gelatinizes in concen. HCl.
orthorhombic	O (eminent)	Contains Si, Al_2, K, Fe, Mg, and water, with small quantities of Na, Ca, and tr. F	G. $\pm$ 2.9. In closed tube gives water, which sometimes shows F.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Clinoclasite‡	O pearly	dark verdigris-green to dark sky-blue	bluish green	2.75	sect. to brittle
Liroconite‡	vitreous to greasy	verdigris-green to sky-blue	same as color	2.75	brittle to sect.
Euchroite‡	vitreous	emerald-gr.	verdigris-green	3	brittle
Chloropal†	feebly lustrous	greenish yellow to pistachio-green	light finch-green	3	sect. to brittle
Dufrenite‡	vitreous to greasy, on ii pearly	dark leek-green	siskin-green	3.25	very brittle
Zaratite† (Emerald Nickel)	vitreous	emerald-green	paler green	3.25	brittle
Eliasite§	pitchy	black	olive-green	3.5	sect. to brittle
Libethenite†	greasy to vitreous	leek-green to blackish green	olive-green	3.5	brittle
Olivenite†	vitreous	leek-green olive-green pistachio-green	olive-green	3.5	brittle
Malachite	vitreous, pearly, and silky	emerald-gr.	verdigris-green	3.5	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
monoclinic	O (perfect)	$*(Cu_5''O'')(As^{V}O_5'')_2^{V} + 12(H_2O)$ (?) with tr. P and Fe	G. ± 4.2. In closed tube gives water. BB fuses, coloring flame bluish green. With soda on coal, button of copper.
monoclinic	.....	Contains As, Cu, Al_2, P, O, and 24 p. c. H_2O	G. 2.8. In closed tube gives much water and turns green. BB cracks open, but does not decrepitate.
orthorhombic	I	$(H_2'Cu_4'')(As^{V}O_5'')_2^{V} + 18(H_2O)$	G. ± 3.4. In closed tube gives water. (For other reactions see *Olivenite.*)
amorphous	.....	$*((Fe_2)^{V}''(SiO_3)_3'') + 9(H_2O)$	G. ± 1.8.
orthorhombic	ii (perfect)	$*((Fe_2)_2^{V}''O'')(P^{V}O_5'')_2^{V} + 5(H_2O)$ [D 2]	G. ± 3.3. In closed tube gives water. BB fuses easily to slag.
incrusting	.....	H_{12},Ni_3,C,O_{11}	G. 2.57. Stalactitic. Minute mammillary. In closed tube yields water and CO_2. BB infusible. Borax O. F. violet bead hot, and reddish brown cold. R.F. green, opaque.
amorphous	fracture uneven, somewhat conchoidal	Contains U_2, Fe_2, Ca, Mg, Pb, Si, P and H_2O	G. ± 4.5. Soluble in HCl.
orthorhombic	.....	$*(H_2'Cu_4'')(P^{V}O_5'')_2^{V}$ [D]	G. 3.7. In closed tube yields water and turns black. BB fuses, colors flame green, and R.F. with soda yields metall. copper.
orthorhombic	.....	$*(H_2'Cu_4'')(As^{V}O_5'')_2^{V}$ [D] (part of As replaced by P)	G. ± 4.3. In closed tube gives water. BB fuses, coloring flame bluish green, and on cooling fused mass is crystalline. With soda on coal, copper. Soluble in ammonia.
monoclinic	O (perfect) ii (less so)	$*Cu_2''(C^{V}O_4)'^{V} + H_2O$	G. ± 3.8. In closed tube blackens and yields water. BB fuses, coloring flame emerald-green. On coal, in R.F., reduced to copper. Effervesces with acids.

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Brochantite‡	vitreous	emerald-gr.	verdigris-green	3.5	brittle
Stilpnomelane‡	vitreous	grayish black to blackish gray	olive-green to gray	3.5	brittle to sect.
Alabandite‡	sub-metallic	iron-black	dirty green to gray	3.75	brittle
Atacamite‡	adamantine to vitreous	emerald- to leek-green	light verdi-gris-green	3.75	brittle
Dioptase†	vitreous	emerald-green	verdigris-green to sky-blue	4.75	brittle
Pseudo-Malachite†	greasy to vitreous	blackish gr. emerald-gr. verdigris-gr.	verdigris-green	5	brittle
Hornblende† (Pargasite?)	vitreous, in part pearly	blackish gr. to velvet-black	mountain-green	5.5	brittle
Spinel	vitreous to greasy	black to green	grayish green	7.5	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
orthorhombic	ii (very perfect)	$*Cu_3''(S^{V}O_6'')^{V'} + 3(H_2O)$	G. ± 3.8. In matrass yields water and turns blackish brown. Mixed with coal powder gives SO_2. Melts on coal in R.F., yielding button of copper.
crystalline	in one direction	Contains Si, Al, Fe_2, Fe, Mg, Ca, K, O, and H	G. ± 3.2. Yields much water. Fuses easily to black metallic globule. Reaction for iron.
isometric	O (perfect)	$Mn''S''$	G. ± 4. Opaque. BB fuses with difficulty. Unchanged in closed tube. With fluxes, reaction for Mn. Soluble in HNO_3 with evolution of H_2S.
orthorhombic	ii (perfect)	$*(Cu_4''Cl_2')^{V}(OH)_6' + 3(H_2O)$ [D 1]	G. 4.1. In closed tube gives off water. BB azure-blue flame. Soda on coal metallic Cu.
hexagonal (rhombohedr'l)	R (perfect)	$*(H_2'Cu'')(Si'^{V}O_3'')_2''$ [D]	G. ± 3.2. In closed tube blackens and yields water. BB blackens without fusing, and colors flame emerald-green. Gelatinizes with HCl.
monoclinic	.....	$*Cu_5''(P^{V}O_5'')_2^{V} + 3(H_2O)$ [D]	G. ± 4.2. In closed tube yields water and turns black. BB fuses, colors flame green, and with soda on coal gives metallic copper. Very little soluble in ammonia.
monoclinic	I (distinct)	Aluminum, Magnesium, Calcium, Iron, Amphibole. Contains also Mn, Na, K, and H_2O	G. ± 3.1.
isometric	1	$Mg''Al_2^{V}O_4''$	G. ± 4.2. Opaque. BB infusible.

VI. Of

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Tyrolite§	pearly	sky-blue to verdigris-green	like color	2.5	sectile
Vivianite†	it metallic pearly, other faces vitreous	indigo-blue to blackish green	light indi-go-blue	2.5	sectile
Liroconite‡	vitreous to greasy	sky-blue to verdigris-green	like color	2.75	brittle to sect.
Linarite‡	vitreous	deep azure-blue	pale blue	2.75	brittle
Azurite†	vitreous or adamant	azure-blue black'h blue smalt-blue	smalt-blue	3.75	brittle
Chrysocolla	feebly glint-ing to lus-treless	sky-blue	smalt-blue	4.5	brittle
Dioptase†	vitreous	emerald-green	sky-blue to verdigris-green	4.75	brittle

Blue Streak.

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
orthorhombic generally crystalline	O (perfect)	$*Cu_5''(As^{v}O_5'')_2^{v} + 9(H_2O)$	G. 3. In closed tube decrepitates and yields much water. Fuses on coal with As. odor. R.F. with soda button of copper.
monoclinic	$i\bar{i}$ (highly perfect)	$*Fe_2''(P^{v}O_4'')_2''' + 8(H_2O)$	G. ±2.5. In closed tube yields neutral water, whitens and exfoliates. BB fuses, coloring flame bluish green to gray, black metallic globule.
monoclinic	.....	$*(Cu_{12}''((Al_2)_2^{v'}O_3''))$-$(P^{v}O_5'')_6^{v} + 36(H_2O)$ Part of P replaced by As	G. 2.8. In closed tube yields much water and turns green. BB cracks open but does not decrepitate.
monoclinic	i–$\bar{i}$ (very perfect) O (less so)	$*(Pb''Cu'')(S^{v'}O_5'')'^{v} + H_2O$	G. ± 5.4. In closed tube yields water and loses color. BB fuses easily to a pearl, and in R.F. yields metallic button, which coats coal with PbO. On fusing this with boric acid Cu is obtained. With soda hepar reaction. Decomposed by HNO_3, leaving white $PbSO_4$.
monoclinic	2–$\bar{i}$ (rather perfect)	$*(H_2'Cu_2'')(C^{v}O_4'')_2'^{v}$	G. ± 3.7. BB (see *Malachite*).
amorphous	fracture conchoidal to uneven	Contains Si, Cu, Fe_2, O, and H_2O	G. ± 2.1. (See before.) Decomposed by acids without gelatinizing.
hexagonal (rhombohedr'l)	R (perfect)	$*(H_2'Cu'')(Si^{v}O_3'')_2''$ [D]	G. ± 3.2. (See before.)

NAME.	LUSTRE.	COLOR.	STREAK.	HARD'SS	TENACITY.
Lapis Lazuli†	greasy to vitreous	azure-blue	smalt-blue	5.5	brittle

CRYSTAL SYSTEM.	CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
isometric	.....	Contains Si, Al_2, Fe_2, Ca, Na, S, O, and H_2O	G. ±2.3. In closed tube gives off water, and that from Chili glows with beetle-green light, but color remains blue. Fuses with intumescence to white glass decomposed by HCl with separation of gelatinous SiO_2 and evolution of H_2S.

MINERALS OF NON-

AND OF WHITE

I. Very

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Petroleum†	.....	black brown yellow white	.....	.....	.....
Nacrite† (Kaolinite ?)	On O pearly	white yellow	<1	sectile	orthorhombic
Scheererite‡	adamantine to resinous	white	1	brittle sectile	monoclinic
Talc	pearly to greasy	white light green	1	very sectile to malleable	orthorhombic
Kaolin (Porcelain earth)	none	white	1	sectile	amorphous
Aluminite†	dull earthy	white	1	sectile	crypto-crystalline
Smectite† (Malthazit)	waxy	white light yellow	1	sect. to malle.	amorphous

METALLIC LUSTRE

OR GRAY STREAK.

Soft.

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
.....	A mixture of the higher members of the Paraffine series C_nH_{2n+2}	G. 0.6 to 0.75. Liquid. Inflammable.
O (perfect)	$*(H_2'(Al_2)^{V'})(Si'^{V}O_4'')_2'^{V}+H_2O$	G. ± 2.5. Unctuous feel. BB infusible. With cobalt solution blue.
.....	Polymeres of Methane (CH_4) and Ethane (C_2H_6)	G. ± 1.1.
O (perfect)	$*(H_2'Mg_4'')(Si'^{V}O_3'')_5''$	G. ± 2.7. In closed tube, when intensely heated, most varieties yield water. BB fusible on very thin edges to white enamel. With cobalt solution a pale red color. Not decomposed by acids.
fracture in large masses, even; in small, earthy	$*(H_2'(Al_2)^{V'})(Si'^{V}O_4'')_2'^{V}+H_2O$	G. ± 2.5. Opaque. Chalky feel. Becomes plastic in water. BB infusible.
fracture earthy	$*(Al_2)^{V''}(S^{V''}O_6'')^{V''}+9(H_2O)$	G. ± 2.6. In closed tube yields much water, which at high temperature becomes acid. With cobalt solution fine blue color. With soda hepar reaction. Soluble in acids.
fracture conchoidal to uneven	$*(H_6'(Al_2)^{V'})(Si'^{V}O_3'')_6''+9(H_2O.)$ Al_2 replaced by Fe_2, Mg, and Ca	G. ± 2. BB Malthazit is infusible, but Smectite and Reigate fuller's-earth, owing to impurities, fuse easily. Decomposed by HCl.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
†**Natron**‡	vitreous	white	1.25	sectile	monoclinic
Felsöbanyite§	pearly	white	1.5	sectile	orthorhombic
Pyrophyllite‡	pearly	white apple-green yellowish	1.5	sectile	orthorhombic
†**Steatite**	dull, more apparent in streak	white gray yellow	1.5	sectile	crypto-crystalline
†**Cerargyrite**†	resinous to adamantine	gray * gray green brown streak shining	1.5	malleable	isometric
† **Calomel**‡	adamantine	white gray brown	1.5	sectile	tetrag.
Alumocalcite†	vitreous	milk-white	1.5	brittle to sect.	amorphous
Collyrite‡	dull to earthy	white	1.5	sectile	amorphous
Sassolite‡	pearly	white pale yellow	1.5	sectile	triclinic
Montmorillonite§ (Stolpenite)	feebly waxy	white light yellow	1.75	sectile	.....

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
.....	$*Na_2'(C'^{v}O_3)'' + 10(H_2O)$	G. 1.4. Soluble in water. Only occurs in powder.
O (perfect)	$((Al_2)_2^{v}O_3'')^{v}(S^{v}O_6'')^{v} + 10(H_2O)$	G. 2.3. BB (see *Aluminite*).
O (eminent)	$*(H_2'(Al_2)^{v})(Si'^{v}O_3'')_4''$	G. ±2.8. Yields water. BB whitens and fuses with difficulty on edges. Radial varieties exfoliate and swell up very much. With cobalt solution blue.
fracture in large masses conchoidal, in small masses splintery	$*(H_2'Mg_4'')(Si'^{v}O_3'')_5''$	G. ±2.7. Very unctuous to touch. BB infusible. (See *Talc.*)
none	$Ag'Cl'$	G. ± 5.4. Fuses without decrepitation. BB on coal button of metallic silver. Added to bead of microcosmic salt, previously saturated with CuO, gives an intensely blue flame. A fragment placed on zinc and moistened with water swells up, turns black, and is reduced to metallic Ag, whose lustre appears on pressing with a knife. Soluble in ammonia.
I (perfect)	$*(Hg_2)''Cl_2'$	G. 6.5. Volatilizable, giving white sublimate. Blackens with alkalies.
fracture uneven	An impure opal SiO_2 mixed with clay or infusorial earth with a little lime and alumina	G. ±2. BB yields water. Infusible.
fracture in large masses, conchoidal; in small, earthy	$*((Al_2)_2^{v}O_4'')^{v}(Si'^{v}O_4'')^{v} + 9(H_2O)$	G. ± 2.1. BB infusible. With cobalt solution blue. Gelatinizes with HNO_3.
basal very perfect	$*H_3'B'''O_3''$	G. ± 1.5. In closed tube gives water. Fuses on wire to clear bead, and tinges flame yellowish green.
fracture conchoidal	$*(Al_2)^{v}(Si'^{v}O_3'')_3'' + 18(H_2O)$ (with Fe_2, Mg, Ca, Na, and K)	G. (?). Soft and unctuous. Softens in water. BB infusible except Stolpenite, which yields a yellow enamel.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Sal Ammoniac†	greasy to vitreous	white yellow	1.75	sectile	isometric
Soda Nitre†	vitreous	white	1.75	sect. to brittle	hexagonal
Mirabilite‡ (Glauber's Salt)	vitreous	white	1.75	sectile	monoclinic
Copalite‡	resinous	yellow brown	1.75	brittle	amorphous
Kalinite†	vitreous	white	1.75	brittle to sectile	isometric
Nitre	vitreous	white	2	sectile	orthorhombic
Gypsum	vitreous if pearly silky	white gray yellow red brown	2	sect. to brittle	monoclinic
Pissophanite‡	vitreous	green brown	2	brittle	amorphous
Melanterite† (Copperas)	vitreous	green, efflores. to white	2	brittle	monoclinic
Alunogen‡ (Keramohalite)	silky	white, partly yellowish	2	sectile	monoclinic
Halotrichite‡	silky fibrous	yellowish white	2	sectile	crystalline

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
octahedral	$(NH_4)'Cl'$	G. 1.5. Sublimes in tube. Heated with $Ca(OH)_2$, gives off ammonia. Dissolves readily in water, and solution precipitates HgCl when added to $AgNO_3$ in solution.
R (perfect)	$Na'(N^vO_3'')'$	G. $\pm$2.1. Deflagrates on coal. Colors flame Na yellow. Soluble in water.
ii (perfect)	$Na_2'(S^vO_4'')'' + 9(H_2O)$	G. 1.5. Cooling taste, then saline and bitter. Fuses. Yields much water. Dissolves easily, and solution precipitates $BaCl_2$ solution. Colors flame yellow.
fracture conchoidal	Oxygenated Hydrocarbon	G. 1.01. Volatilizes by gentle heat. Burns with yellow flame and much smoke. Emits resinous odor when broken.
1 observable	$(K_2'Al_2^v)(S^vO_4'')_4 + 24H_2O$	G. 1.75. Soluble in water. Alum taste. BB fuses in its water of crystallization and froths. With Co. solution, intense blue; and with soda, hepar reaction.
I and ii (observable)	$K'(N^vO_3'')'$	G. 1.9. Taste saline and cooling. Deflagrates vividly on burning coals, and detonates with combustibles. Colors flame violet.
ii (perfect) I (observable)	$*(H_4'Ca'')(S^vO_6'')^v$	G. 2.3. Very little soluble in water. Yields water and becomes opaque.
fracture conchoidal	Hydrous Sulphate of Al_2 and Fe_2	G. 1.9. Probably a mixture.
O (observable)	$*(Fe_2)^v(S^vO_6'')^v + 7(H_2O)$	G. 1.8. Yields water, and becomes brown and finally black and magnetic. With fluxes reacts for Fe.
.....	$*(Al_2)^v(S^vO_4'')_3'' + 18(H_2O)$	G. $\pm$ 1.7. Yields water and SO_2 in closed tube. Blue with Co solution.
.....	$*(Fe''Al_2^v)(S^vO_4'')_4'' + 22(H_2O)$	G. (?). Taste inky, astringent. Fuses in its own aq. of crystallization. Gives off water and SO_2, and leaves brown residue. With soda, hepatic mass.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Brucite†	O pearly	white	2	sectile	hexagonal (rhombohedr'l)
Sepiolite† (Meerschaum)	dull, brightens in streak	white, partly yellowish	2.25	sectile	amorphous
Borax† (Tinkal)	resinous to vitreous	white, in part gray	2.25	brittle to sect.	monoclinic
Tschermigite‡ (NH_4 Alum)	vitreous	white	2.25	brittle	isometric
Goslarite‡	vitreous	white gray	2.25	brittle	orthorhombic
Epsomite‡	vitreous	white pale yellow pale red	2.25	brittle	orthorhombic
Annabergite‡	dull	apple-green	2.25	sect. to brittle	crystalline
Pharmacolite‡	vitreous pearly silky	white	2.25	sectile	monoclinic
Cerolite‡	waxy	white pale yellow	2.25	brittle	amorphous
Senarmontite‡	adamantine resinous	white gray	2.25	brittle to sect.	isometric

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
O (perfect)	$*Mg''(OH)_2'$	G. 2.3. Yields water, becoming opaque. BB infusible, but vividly incandescent. With Co solution, violet red. Soluble in acids.
fracture in large masses, conchoidal; in small, earthy	$*(H_2'Mg_2'')(Si^{IV}O_3'')_2''+H_2O$	G. 0.988—1.279. Can be cut by the nail. Unctuous to the touch, adhering to the tongue. BB yields water and then burnt odor. Violet red with Co solution.
ii (observable)	$*(H_2'Na_2')(B'''O_2'')_4' + 9(H_2O)$	G. 1.7. BB puffs up and fuses to a clear bead called borax glass. Fused with fluor-spar and $(KH)SO_4$ colors flame green.
.....	$*((NH_4)_2'Al_2^{V'})(S^{VI}O_4'')_4''+ 24(H_2O)$	G. 1.5. Alum taste. Yields water and sublimes, leaving coat of itself on tube.
ii (observable)	$Zn''(S^{VI}O_4)'' + 7(H_2O)$	G. 2. Taste astringent, metallic, and nauseous. Yields water. On coal with soda, a coat of ZnO, and hepar reaction.
ii	$*Mg''(S^{VI}O_4)'' + 7(H_2O)$	G. 1.7. Taste bitter and saline.
.....	$*Ni_3''(As^{V}O_4'')_2''' + 8(H_2O)$	G. (?). BB (see page 47).
ii (perfect)	$Ca_2''(As_2^{V}O_7'')^{IV} + 6(H_2O)$	G. 2.6. BB.
fracture in large masses, conchoidal; in small, splintery	$*(H_4'Mg_2'')(Si^{IV}O_4'')_2'^{IV}+ H_2O$	G. 2.3. Does not adhere to the tongue. BB blackens but does not fuse.
.....	$*Sb_2'''O_3''$	G. 5.2. BB in closed tube fuses and partially sublimes. On coal gives white coating, which, in R.F., colors outer flame green-blue.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Halloysite‡	feebly waxy, more apparent in str'k	white pale blue pale green pale yellow	2.25	sect. to brittle	amorphous
Chalcanthite (Blue Stone) (Blue Vitriol)	vitreous	blue	2.25	brittle to sect.	triclinic
Haidingerite‡	vitreous	white	2.25	sectile	orthorhombic
Fuchsite‡ (Muscovite)	pearly	emerald-green	2.5	sectile	crystalline
Biotite†	pearly on O	black brown	2.5	brittle to sect.	hexagonal
Ripidolite (Chlorite)	pearly on O	green to blue	2.5	sectile	monoclinic
Halite	vitreous to resinous	white gray blue (seld.) red (seld.)	2.5	brittle to sect.	isometric
Köttigite‡	pearly silky	white pale red	2.5	sect. to brittle	monoclinic

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
fracture conchoidal	$*((Al_2)^{vi}O'')^{iv}(Si^{iv}O_3'')_2'' + 3(H_2O)$	G. ± 2. BB yields water. Infusible. Fine blue with Co solution.
.....	$*Cu''(S^{vi}O_4'')'' + 5(H_2O)$	G. 2.2. Soluble in water. Moistened and rubbed on knife-blade coats it with copper. BB yields water and SO_3. With soda on coal, metallic Cu.
ii (perfect)	$*(H_2'Ca_2'')(As^vO_4'')_2''' + 3(H_2O)$	G. 2.8. BB in closed tube yields water and becomes opaque. BB O.F. fuses with intumescence to white enamel, and colors flame light blue (As). Readily soluble in acids.
in one direction perfect	Contains Si, Al_2, K, Fe, Mg, and water, with small quantities of Na, Ca, and tr. F. Sometimes 4 p. c. Cr_2O_3	G. 2.9. BB yields water and fuses on thin edges to white or yellow glass. Not decomposed by acids.
O (highly eminent)	$(R''(R_2)^{vi})(Si^{iv}O_4'')_2'^{iv}$. R''= Fe'', Mg'', Ca'', Na_2', K_2', H_2', F_2'. R_2^{vi} = Al_2^{vi}, Fe_2^{vi}, Mn_2^{vi}	G. 2.9. Yields a little water. Whitens and fuses on thin edges. With fluxes, reaction for iron.
O (perfect)	$(R_5''(R_2^{vi}O_2'')'')(Si^{iv}O_4'')_3'^{iv} + 4(H_2O)$. R'' = Fe'', Mg'', and H_2'. R_2^{vi} = Al_2^{vi}, Cr_2^{vi}, and Fe_2^{vi}	G. ± 2.7. BB yields water. In platinum forceps fuses on edges to gray-black glass. In H_2SO_4 wholly decomposed.
cubic perfect	Na'Cl' (with traces Mg, Ca, and S)	G. ± 2.1. Soluble in cold and hot water. Solution precipitates $AgNO_3$. BB fuses often with decrepitation, and colors flame deep yellow.
ii (perfect)	$*Zn_3''(As^vO_4'')_2''' + 8(H_2O)$ (Zn partly replaced by Co and Ni)	G. 3.1. In closed tube gives much water, and at higher temp. cryst. subl. of As_2O_3. On coal, in R.F., copious As fumes, and coats coal with ZnO. With borax, cobalt blue glass.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Succinite† (Amber)	waxy	yellow brown red white	2.5	brittle	amorphous
Bieberite‡	silky to vitreous	flesh- to rose-red	2.5	sect. to brittle	monoclinic
Agalmatolite‡ (Var. Pinite)	dull to shining in specks	gray yellow red green	2.5	sectile	amorphous
+ **Muscovite**	pearly on O	gray white light yellow light brown	2.5	sectile	orthorhombic
Valentinite†	adamantine pearly on O	white gray light yellow light brown	2.5	sectile	orthorhombic
Hydrozincite‡	dull	white	2.5	sect. to brittle	amorphous
Deweylite† (Gymnite)	resinous	yellow	2.5	brittle	amorphous
+ **Lepidolite**†	O pearly, partly submetallic	gray red brown	2.5	sectile	orthorhombic
Phlogopite†	O pearly	black dark brown dark green dark gray	2.75	sect. to brittle	orthorhombic

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
.....	C 79.25 p. c., H 10.41 p. c., O 10.34 p. c.	G. $\pm$ 1. Fuses at 225° Cent. With H_2SO_4 brown solution. Electric by friction.
.....	$*Co''(S^{v}O_4'')''$	G. 1.9. Soluble in water. Yields water and SO_2 in closed tube. Blue borax glass.
fracture splintery	Al_2 and Fe_2 Silicate, with Fe, Mg, Ca, Na, K, O, and H_2O	G. 2.8. Somewhat unctuous to the touch. BB yields water, which is often alkaline. Some varieties fuse easily, others with difficulty.
O (perfect)	$*(K_2'((Al_2)_3''O_4''))(Si^{iv}O_3'')_6''$ Contains Fe, Mg, and water, with small quantities of Na, Ca, and tr. F	G. 3. In closed tube gives water. BB whitens and fuses on thin edges to gray or yellow glass.
O (perfect)	$Sb_2'''O_3''$	G. 5.5. Can be sublimed. In closed tube fuses and partially sublimes. On charcoal fuses easily and gives white coat, which imparts to R.F. green blue color.
fracture conchoidal	Mixture of $Zn''(C^{v}O_3'')'' + 2(Zn''(OH)_2')$	G. $\pm$ 3.6. In closed tube yields water. BB yields CO_2, is yellow while hot. Coats coal near assay, which, with soda, yields Zn vapors. Moistened with Co solution turns green.
fracture conchoidal	$(H_2'Mg_2'')(Si^{iv}O_3'')_2'' + 3(H_2O)$	G. 2.2. Closed tube gives much water. BB fuses on edges and becomes opaque. Decomposed by HCl.
O (highly eminent)	$*(R''((R_2)^{v}O''))(Si^{iv}O_3'')_2''$. $R'' = Mg'', Na_2', Li_2'$, and K_2'; $(R_2)^{v} = (Al_2)^{v}$ and $(Fe_2)^{v}$ tr. of Cl and F	G. $\pm$ 2.9. Yields water. Fuses with intumescence and colors flame lithium-red.
O (highly eminent)	Al_2, Mg, and K Silicate, with Fe_2, Na, H_2O, with 0 to 4.2 p. c. F	G. 2 $\pm$ 8. Yields water which often tests for F. BB whitens and fuses on edges. Decomposed by H_2SO_4.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Carnallite‡	vitreous greasy	red	2.75	sectile	.....
Tachhydrite‡	waxy	yellow	.....	.....	crystalline
Glauberite‡	vitreous to resinous	white yellow red	2.75	brittle	monoclinic
Mellite‡	greasy	yellow brown white	2.75	brittle	tetragonal
Phosgenite‡	adamantine to resinous	gray white pale yellow pale green	2.75	brittle	tetragonal
Mendipite‡	adamantine, pearly on cleavage planes	yellow white to pale yellow	2.75	brittle	orthorhombic
Chrysocolla (One variety)	dull	verdigris-green to sky-blue	2.75	brittle	amorphous
Caledonite‡	resinous	verdigris-green mountain-green	2.75	brittle	orthorhombic
Dillnite§	none	white	2.75	sectile	amorphous
Pimelite‡	waxy	apple-green	2.75	brittle	amorphous

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
.....	Mixture of $2(MgCl_2)+KCl$, containing $12(H_2O)$	BB fuses easily. Soluble in water.
in two directions	Mixture of $2(MgCl_2)+CaCl_2$, containing $12(H_2O)$	BB fuses easily, very soluble, and deliquescent on exposure to air.
O (perfect)	$*(Na_2',Ca'')''(S^{v}O_4'')''$ (with tr. Fe and Cl)	G. $\pm$ 2.7. Partially soluble in water. BB decrepitates, turns white, and fuses, coloring flame yellow. With soda gives hepar reaction.
1 (indistinct)	$Al_2^{v'}\overline{M}_3 + 18(H_2O)$	G. $\pm$ 1.5. Whitens in candle-flame but does not take fire. Yields water. Decomposed by boiling water. Soluble in HNO_3.
I and ii (perfect)	CO_3,Pb_2,Cl_2. $(C^{v}O_3'')''=Pb^{iv}=Pb^{iv}=Cl_2'$ (?)	G. $\pm$ 6.2. Melts easily to yellow globule, which, on cooling, becomes white and crystalline. On coal, in R.F., metallic lead and white coat of $Pb''Cl_2'$. Bead of microcosmic salt with Cu gives reaction for Cl.
I (perfect)	Pb_2,O_2,Cl_2. $*Pb''=O_2''=Pb^{iv}=Pb^{iv}=Cl_2'$ (?)	G. $\pm$ 7.1. In closed tube decrepitates and becomes more yellow. Fuses easily to lead button, and with microcosmic bead and Cu shows Cl.
fracture conchoidal	Contains Si, Cu, Fe_2, O, and H_2O	G. $\pm$ 2.2. BB infusible. In closed tube blackens and yields water. With fluxes, reaction for copper.
ii	Principally $Pb''(S^{v}O_4'')''$. Mixed with $Pb''(C^{v}O_3'')''$ and $Cu''(C^{v}O_3'')''$	G. $\pm$ 6.3. In HCl partly soluble with effervescence. With soda, in R.F., button of lead.
fracture earthy	Hydro-aluminic Silicate	G. $\pm$ 2.7. Yields water. BB infusible. Gelatinizes with HNO_3.
fracture conchoidal	Hydro-nickel Silicate, containing Fe_2, Al_2, Mg, and Ca	G. $\pm$ 2.3. Unctuous to touch. BB infusible. Yields water, and with fluxes reacts for Ni.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Arsenolite‡	adamantine	white	2.75	sectile	isometric

II.

Wulfenite†	adamantine vitreous resinous	yellow white(seld.) brown(seld.)	3	brittle to sect.	tetragonal
Stolzite‡	resinous	gray brown	3	sectile	tetragonal
† **Calcite**	vitreous	in all colors, generally white	3	brittle	hexagonal (rhombohedr'l)
Vanadinite‡	resinous	yellow brown	3	brittle	hexagonal
† **Anhydrite**	vitreous ii pearly	white pale red pale blue gray	3	brittle	orthorhombic

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
.....	*$As_2'''O_3''$	G. ± 3.7. Sublimes in tube, condensing on walls in minute octahedrons. Volatilizes on coal, giving As odor and white fumes.

Soft.

O (distinct)	*$Pb''(Mo^{v}O_4'')''$	G. ± 6.5. Closed tube decrepitates and fuses. With borax colorless glass, which, in R.F., becomes dirty green. With soda on coal, metallic lead.
O (imperfect)	*$Pb''(W^{v}O_4'')''$	G. ± 8. BB decrepitates and fuses to a crystalline, lustrous, and metallic pearl. With microcosmic salt in O.F. colorless glass, which, in R.F., becomes blue on cooling. Decomposed by HNO_3, leaving yellow residue of H_2WO_4.
R (highly perfect)	$Ca''(C^{v}O_3'')''$	G. ± 2.6. BB infusible. Strongly luminous. Soluble in acids with effervescence.
.....	$Pb_3''(V^{v}O_4'')_2'''$ with some $Pb''Cl_2'$	G. ± 6.9. In closed tube decrepitates and yields faint white sublimate. Fuses on coal to black mass, which, in R.F., gives metallic bead. After oxidizing all the lead the black residue gives, with microcosmic salt in O.F., green bead, which becomes yellow in O.F.
ii (perfect) ii (noticeable)	*$Ca''(S^{v}O_4'')''$ with more or less tr. Si, C, Fe_2, and H_2O	G. 2.9. Fuses, coloring flame reddish yellow, and yielding bead which reacts alkaline. Soluble in HCl.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
† **Celestite** (Cölestin)	vitreous O somewhat pearly	white blue	3	brittle	orthorhombic
† **Barite**	vitreous O somewhat pearly	all colors, principally red and yellow	3	brittle	orthorhombic
† **Anglesite**	adamantine	white	3	very brittle	orthorhombic
† **Polyhalite**‡	vitreous resinous silky	red gray (seld.)	3	brittle	orthorhombic (usually compact fibrous)
† **Cryolite**†	vitreous	white	3	brittle	orthorhombic?
Allophane†	vitreous	white blue yellow green brown	3.25	brittle	amorphous
Wavellite†	vitreous silky	in all colors, principally yellow	3.25	brittle	orthorhombic
Peganite‡	vitreous resinous	green gray white	3.5	brittle	orthorhombic

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
O (perfect) I (observable)	$*Sr''(S^{v}O_4'')''$	G. 3.9. Decrepitates and fuses to white pearl, coloring flame red, and giving off SO_2. Residue alkaline. With soda, hepar reaction on silver.
O (perfect) I (observable)	$*Ba''(S^{v}O_4'')''$	G. 4.3—4.7. Decrepitates and fuses, coloring flame yellowish green, and giving off SO_2. With soda, hepar reaction on silver.
O (perfect) I (observable)	$*Pb''(S^{v}O_4'')''$	G. ± 6.2. Decrepitates. Fuses in candle-flame. On coal, in O.F., clean bead, which becomes milk-white on cooling. With soda, hepar reaction.
.....	$*(Ca''Mg''K_2')(S^{v}O_4'')_2'' + 2(H_2O)$, containing Na, NaCl, and Fe_2	G. 2.7. Yields water. BB fuses and colors flame yellow. On coal fuses to reddish bead, which, in R.F., becomes white. Partially soluble in water, leaving $CaSO_4$, which dissolves in large excess of water.
O (perfect)	Al_2, Na_6, F_{12}, corresponding to mixture $(Al_2)^{v'}F_6' + (NaF)_6$	G. ± 3. Melts in candle-flame. Heated in open tube so that flame enters tube, gives off HOF and etches glass. Colors flame yellow, and gives blue with Co solution.
fracture conchoidal	$*(Al_2^{v''}O'')^{'v}(Si^{'v}O_4'')^{'v} + 6(H_2O)$	G. 1.8. BB infusible. Yields much water in closed tube. Crumbles. Gelatinizes with HCl.
ii (distinct)	$*((Al_2)_2^{v''}O_3'')(P^{v}O_4'')_4''' + 12(H_2O)$	G. 2.3. Yields much water, last portions of which taste acid. In forceps swells and splits to fine acicular particles, which are infusible, but color flame green. With Co solution, blue.
.....	$*((Al_2)_2^{v''}O'')^{x}(P^{v}O_5'')_2^{v} + 6(H_2O)$	G. 2.5. Yields water and becomes violet. Cracks open.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
†Serpentine† (Chrysotil)	feebly lustr. to earthy *chrysotil* silky	dark green, less freq'tly yellow, red, brown	3.5	brittle to sect.	micro- and crypto-crystalline
Stilpnomelane†	vitreous pearly	blackish green	3.5	brittle to sect.	crystalline
Voltzite‡	greasy	brown yellow	3.5	brittle	amorphous
Pyromorphite	resinous to vitreous	green brown yellow white	3.5	brittle	hexagonal
†Mimetite†	resinous to adamantine	yellow white gray	3.5	brittle	hexagonal
†Cerussite	adamantine	white, also gray and black	3.5	brittle	orthorhombic
Laumontite‡	vitreous I pearly	white pale yellow	3.5	brittle	monoclinic
†Stilbite† (Desmin)	vitreous i–ĭ pearly	white, less freq'tly yellow, brown, and red	3.75	brittle	orthorhombic
†Heulandite‡	vitreous i–ĭ pearly	white, red, less frequently yellow, brown	3.75	brittle	monoclinic

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
fracture of cryp., conchoidal to splintery	$*(H_2'Mg_3'')(Si^{IV}O_4'')_2'^{V} + H_2O$	G. ± 2.6. Yields water, fuses on edges with difficulty. Decomposed by HCl and H_2SO_4. Chrysotil leaves SiO_2 in fine fibres.
perfect in one direction	$R_2^{V}(Si^{IV}O_2'')_3'' + 2(H_2O)$. Containing varying amounts of R''. $R_2^{V} = Al_2^{V}$, Fe_2^{V}; R'' = Fe'', Mg'', Ca'', and K_2'	G. ± 3.2. Yields much water. Fuses easily to black, shining metallic bead, which gives tests for iron.
fracture conchoidal	Mixed Oxide and Sulphide of Zinc	G. ± 3.7. BB yields SO_2 and changes color. In HCl yields H_2S.
.....	$*Pb_3''(P^{V}O_4'')_2'''$ mainly, with $Pb''Cl_2'$, $Ca''Cl_2'$, and $Ca''F_2'$, generally in the proportion $*(Pb_3''(P^{V}O_4'')_2)_3 + Pb''Cl_2'$	G. 6.5 — 7.1. In closed tube, white sublimate ($PbCl_2$). Fuses easily, coloring flame bluish green. Fuses on coal, and, on cooling, assumes polyhedral forms. Soluble in HNO_3. Cl reaction with microcosmic salt and CuO.
1 (imperfect)	$*Pb_3''(As^{V}O_4'')_2'''$ mainly, with $Pb''Cl_2'$ in proportion. $*(Pb_3''(As^{V}O_4'')_2''')_3 + Pb''Cl_2'$. Pb replaced by Ca, and As by P in varying proportions.	G. ± 7.1. Closed tube like above. In R.F. As odor and reduced to metallic lead. Reacts for Cl with bead of microcosmic salt saturated with CuO by coloring flame azure blue.
I (perfect) 1–ĭ (distinct) i–ĭ (distinct)	$*Pb''(C^{IV}O_3'')''$	G. 6.4. Closed tube decrepitates and turns yellow. Fuses very easily, and, in R.F., yields metallic lead. Soluble with effervescence in HNO_3.
I (distinct)	$*(Ca''Al_2^{V})(Si^{IV}O_3'')_4'' + 4(H_2O)$, tr. Fe_2, K, Na, and Mg	G. 2.3. BB fuses and swells up to white enamel. Gelatinizes with HCl.
i–ĭ perfect i–ī less so	$*(H_4CaAl_2)(SiO_3)_6 + 5(H_2O)$	G. 2.1. BB exfoliates and curves into vermicular forms, and fuses to a white enamel at ± 2.25. Attacked by acids without gelatinizing.
i–ĭ eminent	$(H_4CaAl_2)(SiO_3)_6 + 3H_2O$	G. ± 2.2. BB curls up, exfoliates, and fuses to white enamel. Decomposed by HCl without gelatinizing.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Scorodite†	vitreous	green	3.75	brittle	orthorhombic
Schiller Spar† (Var. Serpentine)	sub-metallic on cleavage planes	green	3.75	brittle	orth'rh'bic (?)
Alunite†	vitreous O pearly	white yellow red brown	3.75	brittle	hexagonal
† **Strontianite**	vitreous	white pale yellow pale green	3.75	brittle	orthorhombic
† **Witherite**†	vitreous to resinous	white pale yellow	3.75	brittle	orthorhombic
† **Aragonite**	vitreous	white yellow less freq'tly gray, blue, red	4	brittle	orthorhombic
Triphylite† (Triphylin)	resinous	green gray blue	4	brittle	orthorhombic
Picrolite‡ (Variety of Serpentine)	feebly waxy	yellow green white	4	brittle	amorphous columnar

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
O (perfect) i–ĭ (distinct)	$*(Fe_2)^{V}(As^{V}O_4'')_2''' + 4(H_2O)$	G. ± 3.2. In closed tube yields neutral water and turns yellow. BB fuses easily, coloring flame blue, leaving magnetic scoria.
in one direction perfect, and in two others imperfect	$(H_2'Mg_2'')(Si'^{V}O_4'')_2'^{V} + H_2O$ with some Cr; and occasionally organic matter	G. 2.5. BB very difficult to fuse.
O (perfect)	$*(H_4'K_2'(Al_2)_3^{V})(S^{V}O_8'')_4^{V} + 4(H_2O)$	G. ± 2.6. Decrepitates and is infusible. Yields water sometimes $(NH_4)_2SO_4$. With Co solution yields fine blue color. With soda, hepar reaction.
I (distinct) 1–ĭ (distinct)	$*Sr''(C^{V}O_3'')''$, with Ca, Fe, Mn, and tr. H_2O	G. ± 3.7. Swells up. Throws out minute sprouts, fuses only on thin edges, and colors flame Sr red. Effervesces with acids. H_2SO_4 produces precipitate in dilute solution.
I (distinct) i–ĭ 1–ĭ } less so	$*Ba''(C^{V}O_3'')''$	G. ± 4.2. Fuses to bead and colors flame yellowish green. Assay tests alkaline after fusion. Dissolves in HCl with effervescence. The dilute solution precipitates white with H_2SO_4
i–ĭ (distinct) I 1–ĭ } traces	$*Ca''(C^{V}O_3'')''$. Containing generally Sr and H_2O, sometimes $H_2Fe_2O_4$, rarely $PbCO_3$	G. 2.9. BB falls to pieces, loses CO_2, and glows brightly. Dissolves with effervescence in acids. Moistened with HCl gives lime-color to flame.
i–ĭ (distinct) O (less so)	$*(Fe'',Mn'',Li_2')_3''(P^{V}O_4'')_2'''$ (*Oesten's Analysis of Pure Mineral*). Generally contains Mn, Mg, Ca, Na, K, Si, and H_2O	G. ± 3.6. BB turns dark and gives off some water. Fuses, coloring flame Li red, with pale bluish green at exterior cone of flame. With borax, an iron bead; with soda, reaction for Mn solution in HCl.
fracture in large pieces, conchoidal; in small, splintery	Hydrous Mg Silicate with Al_2^{V} and Fe''	G. ± 2.5. Fibres not flexible. Yields water. Fuses on edges with difficulty.

NAME.	LUSTRE.	COLOR.	HARD'SS	TENACITY.	CRYSTAL SYSTEM.
Zinc Blende (Blende or Sphalerite)	adamantine	yellow red green very seldom white very seldom	4	very brittle	isometric
Fluorite	vitreous	in all colors, black, red, and brown are most *uncommon*	4	brittle	isometric
Dolomite	vitreous R partly pearly	white yellow red brown green	4	brittle	hexagonal (rhombohedr'l)
Siderite (Spathic Iron)	vitreous O pearly	pale yellow Isabella-yel. yellow gray yellow b'wn	4	brittle	hexagonal

CLEAVAGE.	CHEMICAL FORMULA.	REMARKS.
I (perfect) Bethlehem variety very slight	$Zn''S''$, frequently contains Fe, Ca, Cu, Mn, Sb, and Pb in traces	G. ±4. Open tube SO_2, and generally changes color. Very difficult to fuse. With soda on coal green Zn flame. In R.F. on coal a zinc coat. Bethlehem variety cryptocrystalline.
1 (perfect)	$*Ca''F_2'$	G. ±3.1. In closed tube decrepitates and phosphoresces. BB fuses, coloring flame red. Residue reacts alkaline. With H_2SO_4, fumes etch glass.
R (perfect)	$*(Mg'',Ca'')(C^{v}O_3'')''$. Varying proportions of Mg to Ca	G. 2.8. BB does not fuse to clear mass with soda on platinum foil. Glows and gives off CO_2. Fragments dissolve slowly in cold HCl.
R (perfect)	$*Fe''(C^{v}O_3'')''$. Contains often Mn, Mg, and Ca	G. ±3.8. BB decrepitates, evolves CO_2, blackens, and becomes magnetic. With fluxes reacts for Fe, and with soda and nitre on platinum foil generally for Mn. Dissolves with effervescence in HCl.

III.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
† **Magnesite**†	vitreous	white pale yellow	4.5	hexagonal (rhombohedr'l)	R (perfect)
† **Rhodochrosite**† (Rose Spar)	vitreous partly pearly and resinous	rose red	4.5	hexagonal (rhombohedr'l)	R (perfect)
† **Smithsonite**	vitreous to resinous	white pale yellow pale green	4.5	hexagonal (rhombohedr'l)	R (perfect)
† **Margarite**† (Perl-Glimmer)	O pearly	white gray	4.5	orthorhombic	O (perfect)
Scheelite† (Scheelspath)	resinous to adamantine	brown yellow gray white	4.5	tetrag.	1 2–i O } perfect
Triplite†	resinous	brown	4.5	orthorhombic	i–ĭ (distinct) O (less so)
† **Wollastonite**†	vitreous O pearly	white seldom pale red	4.5	monoclinic	O (perfect)

Semi-hard.

CHEMICAL FORMULA.	REMARKS.
*$Mg''(C^{v}O_3'')''$ with Fe often, and sometimes tr. Ca, Mn, and H_2O	G. 3. BB whitens, loses CO_2, and glows brightly. Residue alkaline. With Co solution on platinum foil red color. Effervesces with acids.
*$Mn''(C^{v}O_3'')''$ contains Mg, Ca, and Fe	G. $\pm$ 3.5. BB changes to gray brown and black. Decrepitates but is infusible. With microcosmic salt and borax, in O.F., amethyst bead. R.F., by continued blowing, colorless, Co solution on platinum foil bluish green. Dissolves with effervescence in warm HCl.
*$Zn''(C^{v}O_3'')''$. Contains Fe'', sometimes Mg, Ca, and Pb, and rarely Cu	G. $\pm$ 4.2. In closed tube yields Co_2, and is yellowish hot and white cold. BB infusible. Co solution gives green color. Soluble in HCl with effervescence.
$R'',(R_2)_2^{v},Si_2'^{v},H_2',O_{12}''$, perhaps: $\begin{matrix}HO\\|*R''-O''-(R_2)^{v}\equiv(Si'^{v}O_4'')'^{v}\\-O''-(R_2)^{v}\equiv(Si'^{v}O_4'')'^{v}\\|\\HO\end{matrix}$ *i.e.* $R''O_2''(OH)_2'(R_2)_2^{v}(Si'^{v}O_4'')_2'^{v}$. R''= Mg, Ca, Na_2, K_2; $R_2^{v}=Al_2$ and Fe_2^{v}	G. 3. Yields water in closed tube, whitens, and fuses on edges.
*$Ca''(W^{v}O_4'')''$	G. $\pm$ 6. Fuses to semi-transparent glass, which is opaque on cooling. With microcosmic salt, a bead colorless in outer flame; in inner, green while hot and blue when cold. Decomposed by HCl, leaving yellow residue, soluble in ammonia.
*$(R_4''F_2')^{6}(P^{v}O_3'')_6'$. R''= Fe'', Mn'', and Ca'', containing some Mg, Na, Fe, Si, F, and H_2O	G. $\pm$ 3.6. Fuses easily to black magnetic globule. With borax, in O.F., amethyst bead of Mn; soda, Fe reaction. With H_2SO_4 evolves F and etches glass.
*$Ca''(Si^{v}O_3'')''$ (containing tr. Fe, Mg, and H_2O)	G. $\pm$ 2.8. Rubbed or warmed becomes phosphorescent in the dark. In matrass no change. BB fuses easily on edges. Gelatinizes with HCl.

NAME	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
†**Chabazite**†	vitreous	white	4.5	hexagonal (rhombohedr'l)	R (distinct)
†**Apophyllite**†	vitreous O pearly	white pale yellow pale red	4.75	tetrag.	O (distinct) i–i (distinct)
Prosopite‡	vitreous	white	4.5	orthorhombic	I (distinct) i–ĭ (distinct)
Eulytite‡ (Kieselwismuth)	adamantine	brown yellow gray white	4.75	isometric	I (very imperfect)
†**Calamine**	vitreous	white pale yellow	4.75	orthorhombic	I (perfect)
Diaclasite† (Diaklas)	metalloidal i–ĭ pearly	green brown gray	4.75	monoclinic	i–i (perfect) iĭ (imperfect)
Enstatite† (Bronzite)	vitreous to resinous i–ĭ metallic pearly	brown	5	orthorhombic	i–ĭ (perfect) I (imperfect) i–ī (in traces)
†**Apatite**	vitreous resinous	in all colors	5	hexagonal	O (distinct) I (distinct)
Carpholite‡	silky	straw-yellow	5	crystalline	.....

CHEMICAL FORMULA.	REMARKS.
$*(R''R_2''')(Si'''O_3'')_4'' + 6(H_2O)$. $R'' = Ca''$, Na_2', K_2'. $R_2''' = Al_2'''$	G. $\pm$ 2.1. BB intumesces and fuses to bleb-by glass nearly opaque. Decomposed by HCl with separation of gelatinous silica.
$*(H_2'R'')(Si'''O_3'')_2'' + H_2O$. $R'' =$ Ca'' and K_2'. Contains 0.46 — 1.5 p. c. F and tr. Mg, Al_2, and Na	G. 2.3. In closed tube exfoliates, whitens, and yields water. BB exfoliates and colors the flame violet. With acids slimy silica.
Si, F, Al_2, Mn, Mg, Ca, K, and H_2O	G. 2.9. In closed tube yields water and SiF_4. Decomp. by H_2SO_4. Isomorphic with Datolite.
$*Bi_4'''(Si'''O_3'')_6''$, with a small quantity of P, Fe, F, and H_2O. In Kersten's analysis, from which the above formula was calculated, the ratio is more nearly Bi : Si : O :: 4 : 5 : 16	G. 6. In matrass decrepitates and yields a little water. Fuses and froths on coal, staining it yellow brown. Fuses with soda to button at first greenish yellow, then reddish yellow, and yields finally metallic Bi.
$*Zn_2''(Si'''O_4'')''' + H_2O$	G. 3.16 — 3.9. In closed tube decrepitates, whitens, and gives water. Moistened with Co solution gives green color when heated. On coal with soda gives yellow coat, which cools to white. By HCl decomposed and gives gelatinous silica.
$*(Mg'',Fe'',Ca'')''(Si'''O_3'')''$, with Al_2, Mn, and water, and sometimes Cr	G. 3. BB infusible, being only slightly rounded on their edges. Insoluble in HCl.
$*Mg''(Si'''O_3'')''$. Contains Al_2, Fe, Mn, Ca, and H_2O	G. $\pm$ 3.2. BB (same as preceding).
$*Ca_3''(P'''O_4'')_2'''$ with 7–8 p. c. $Ca''Cl_2$ and $Ca''F_2$	G. $\pm$ 3.1. BB fuses with difficulty on edges, coloring flame reddish yellow. Moistened with H_2SO_4 colors flame bluish green. Some varieties give blue flame when treated with microcosmic bead saturated with CuO—(Cl), and some give F when fused with microcosmic salt in open tube.
$*(Al_2''',Mn_2''',Fe_2''')_3'''(Si'''O_4'')_3''' + 3(H_2O)$. Contains some Fe'', Ca'', and F	G. 2.9. In closed tube gives some water, which reacts acid and attacks the glass (F). BB swells up and fuses to brown glass. With fluxes gives reactions for Mn and Fe. Not decomposed by HCl.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Pyrgom† or **Fassaite** (Var. Pyroxene)	vitreous partly resinous	green	5	monoclinic	I (distinct)
Haüynite‡	vitreous to resinous	blue	5	isometric	I (perfect)
Magnesite† (Granular compact var.)	dull to chalky	white	5	.....	fracture conchoidal
Datolite†	vitreous to resinous	white	5	monoclinic	O (distinct)
Faujasite‡	adamantine	white light brown	5	isometric	1 (distinct)
Pyroxene	vitreous to resinous some pearly	green various shades	5.5	monoclinic	I rather perfect O sometimes easy
Pectolite	silky and sub-vitreous	whitish or grayish	5	monoclinic	i–i perfect

IV.

Harmotome†	vitreous	white light yellow light brown	5.25	monoclinic	i–ī (perfect) O (imperfect)
Phillipsite‡	vitreous	white	5.25	monoclinic	i–ī (perfect) O (imperfect)
Natrolite†	vitreous O pearly	white light yellow light red	5.25	monoclinic	I (perfect)
Opal	vitreous waxy	in all colors except blue	5.25	amorphous	fracture conchoidal to uneven
Perlite‡	vitreous part. pearly	gray	5.25	amorphous	fracture conchoidal

CHEMICAL FORMULA.	REMARKS.
$*((Al_2^{v\prime}O_2^{\prime\prime})^{\prime\prime}(Fe^{\prime\prime},Mg^{\prime\prime})_7^{\prime\prime}Ca_5^{\prime\prime})^{xxv\prime}(Si^{iv}O_3^{\prime\prime})_{13}^{\prime\prime}$	G. $\pm$ 3.3. Includes green pyroxene found in metamorphic rocks.
$Na_6,Si_6,(Al_2)_3,Ca_2,S_2,O_{22}$. Possibly containing $*(Na_2^{\prime}Al_2^{v\prime})(S^{v\prime}O_4^{\prime\prime})_4^{\prime\prime}$ (Sodium alum), $(Ca^{\prime\prime}Al_2^{v\prime}O_4)_3$ (lime spinel), $(Na_{10}^{\prime}(Al_2)_2^{v\prime}Ca^{\prime\prime})(Si^{iv}O_3^{\prime\prime})_{12}^{\prime\prime}$ Ratio of elements as above.	G. $\pm$ 2.4. In closed tube retains its color. BB in forceps fuses to a white glass. Fused with soda on coal gives hepar reaction with silver. Decomposed by HCl, with separation of gelatinous silica.
$*Mg^{\prime\prime}(C^{iv}O_3^{\prime\prime})^{\prime\prime}$, with occasionally Mn, Fe, Ca, and H_2O	G. 3. Chalky to the touch. Feebly adhesive to the tongue. BB infusible, but glows brightly. Soluble in HCl with effervescence.
Ca_2, B_2, Si_2, H_2, O_{10}	G. 2.9. In closed tube yields much water. BB fuses with intumescence to clear glass, coloring flame bright green.
$*(H_2^{\prime}R_2^{\prime\prime}(Al_2)_2^{v\prime})(Si^{iv}O_3^{\prime\prime})_9^{\prime\prime} + 17(H_2O)$. $R^{\prime\prime} = Ca^{\prime\prime}$, $Na_2^{\prime}$, $H_2^{\prime}$	G. 1.9. BB fuses with intumescence to a white blebby enamel. Decomposed by HCl without gelatinization.
$R^{\prime\prime}(SiO_3)^{\prime\prime}$. $R^{\prime\prime} =$ Ca, Mg, Mn, Fe, sometimes Zn, K_2, Na_2	G. 3.39. Chief varieties are (*a*) non-aluminous, (*b*) aluminous. Most varieties not affected by acids.
$(HNaCa_2)(SiO_3)_3$, almost always Al_2O_3, sometimes Fe, Mg, Na, K	G. $\pm$ 2.73. In closed tube yields water. BB fuses at 2 to white enamel. Gelatinizes with HCl. Emits light when broken in the dark.

Hard.

$*(H_2^{\prime}R^{\prime\prime}R_2^{v\prime})(Si^{iv}O_3^{\prime\prime})_5^{\prime\prime}$. $R^{\prime\prime} = Ba^{\prime\prime}$, $K_2^{\prime}$, and sometimes Ca and $Na_2^{\prime}$. $R_2^{v\prime} = (Al_2)^{v\prime}$	G. 2.4. BB whitens and then crumbles, and fuses, without intumescence, to white translucent glass. Sometimes phosphorescent when heated. Gelatinizes with HCl.
$(R^{\prime\prime}R_2^{v\prime})(Si^{iv}O_3^{\prime\prime})_4^{\prime\prime} + 5(H_2O)$. $R^{\prime\prime} =$ Ca, $K_2^{\prime}$, and sometimes $Na_2^{\prime}$. $R_2^{v\prime} = Al_2^{v\prime}$	G. 2.2. BB (same as preceding).
$*(H_4^{\prime}Na_2^{\prime}Al_2^{v\prime})(Si^{iv}O_4^{\prime\prime})_3^{\prime v}$	G. $\pm$ 2.2. BB fuses quietly to a colorless glass. Fuses in the flame of an ordinary wax candle. Gelatinizes with acids.
$Si^{iv}O_2^{\prime\prime}$, containing usually water and often some Fe, Ca, Al, K, and Mg	G. $\pm$ 2. BB yields water. Infusible, but becomes opaque. Some yellow varieties turn red.
Albite and Oligoclase or Orthoclase felspars, occurring as an *acidic igneous* rock. Silica 70 p. c.	G. $\pm$ 2.4.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Pitchstone†	resinous	green red brown black	5.5	amorphous	fracture conchoidal
Wagnerite‡	resinous to vitreous	yellow	5.25	monoclinic	I i–i } imperf.
Amblygonite‡	vitreous resinous pearly	white gray pale green and yellowish green	5.5	triclinic	O (perfect) i–ī (nearly perfect)
† **Lazulite**†	vitreous	blue	5.5	monoclinic	.....
† **Amphibole** (Hornblende)	vitreous to pearly	black to white, through various shades of green	5.5	monoclinic	I highly perf. i–i and i–ī sometimes distinct.
† **Willemite**†	vitreous	white gray pale yellow	5.5	hexagonal	I–2(N. J.) O (Moresnet) both easy
† **Thomsonite**†	vitreous part. pearly	white	5.5	orthorhombic	i–ĭ (distinct) i–ī(indistinct)
Analcite† (Analcim)	vitreous	white pale red	5.5	isometric	cubic in traces
Nosite§ (Nosean)	vitreous	gray	5.5	isometric	I (perfect)
Sodalite‡	greasy to vitreous	blue gray green	5.5	isometric	I (perfect)

CHEMICAL FORMULA.	REMARKS.
Principally Al_2 Silicate, with Ca, Mg, K, Na, and H_2O	G. ± 2.2. Generally considered a *rock*.
$*Mg_3''(P^vO_4'')_2'''$. Contains some Fe, F, and Al_2	G. 3. BB fuses in forceps to greenish gray glass. Moistened with H_2SO_4 colors flame bluish green. With borax, iron reaction; with soda, effervesces, but not entirely dissolved. With H_2SO_4 gives off HF.
$*(Li_2'(Al_2^vO'')^{v})(P^vO_4'')_2'''$ [Berz.]	G. ± 3.1. In closed tube yields water, which finally, at high heat, becomes acid and corrodes glass. Fuses easily with intumescence, and cools into opaque white. Colors flame yellow red, with cobalt solution deep blue. In fine powder dissolves in H_2SO_4.
$*(H_2'R''Al_2^v)(P^vO_5'')_2^v$. R″ = Mg″ and Ca″	G. 3. In closed tube whitens and yields water. Cobalt solution the blue color is restored. In forceps whitens, swells, and falls to pieces without fusing, coloring flame bluish green.
$R''(SiO_3)''$. R″ = Mg, Ca, Fe, Mn	G. ± 3.1. BB same as pyroxene (p. 84). Differs by distinct prismatic cleavage, I∧I 124°, and in colored varieties by dichroism in thin sections. Commonly fibrous or columnar. Compounds resembling pyroxene have $\frac{1}{14}$ higher G.
$*Zn_2''(Si^vO_4'')^{v}$	G. ± 4. BB glows and fuses with difficulty to white enamel. Powder with soda on coal gives yellow coating while hot and white on cooling. Decomposed by HCl, with separation of gelatinous silica.
$*(R''(R_2)^{v'})(Si^vO_4'')_2^{v} + 5(H_2O)$	G. ± 2.3. BB fuses with intumescence to white enamel. Gelatinizes with HCl.
$*(R''(R_2)^{v'})(Si^vO_3'')_4'' + 2(H_2O)$	G. 2.2. Yields water. Fuses to colorless glass. Gelatinizes with HCl.
$Si_{15},(Al_2)_6,Na_{10},S_2,O_{50}$ [D 1]	G. ± 2.3. In forceps fuses to white glass. With soda on coal, hepar reaction with silver. Gelatinizes with HCl.
$Si_8,(Al_2)_3,Na_8,Cl_2,O_{20}$ [D 1]	G. ± 2.1. In closed tube blue varieties become white and opaque. Fuses with intumescence to colorless glass. Gelatinizes with HCl and HNO_3.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Perofskite‡ (Perowskite)	tarry adamantine sub-metallic	black brown red yellow	5.5	isometric	cubic distinct
†Brookite†	adamantine	red brown	5.5	orthorhombic	I (sometimes distinct)
Andesite†	sub-vitreous inclining to pearly	white, gray greenish yellowish flesh-red	5.5	triclinic	more uneven than Albite
Gehlenite‡	greasy	green brown	5.5	tetragonal	O (distinct)
†Andalusite (Chiastolite)	feebly lustrous to earthy	gray white yellow brown	5.5	orthorhombic	I (distinct)
†Cyanite (Disthene)	vitreous part. pearly	blue white yellow	±5.5	triclinic	i–ī (perfect) i–ĭ (less so) O (imperfect)
†Enstatite†	I pearly	light gray light yellow light green	5.5	orthorhombic	I (distinct) i–ĭ i–ī } indistinct
†Wernerite† (Scapolite)	greasy vitreous i–i pearly	in all colors	5.5	tetragonal	I i–i (dist. but interrupted)
Ekebergite‡ (Porzellanit)	vitreous i–ĭ partly pearly	white gray	5.5	tetragonal	I } distinct i–i } but interrupted
†Rhodonite†	vitreous part. pearly	red partly blue and brown	5.5	triclinic	I (perfect)
Tephroite†	vitreous part pearly	red partly blue and brown	5.75	orthorhombic	in three perpendicular directions

CHEMICAL FORMULA.	REMARKS.
*$Ca''(Ti'^{v}O_3'')''$, with some Fe''	G. 4. BB in forceps and on coal infusible. Microcosmic salt, greenish bead hot, in O.F., colorless on cooling. R.F. changes to gray green, and assumes violet tint on cooling.
$Ti'^{v}O_3''$	G. ± 4.2. BB infusible. With microcosmic salt, colorless bead, which, in R.F., assumes violet tint on cooling. The Fe impurity obscures the violet unless treated with tin on coal. Insoluble in acids until fused with alkali hydrate or carbonate. Acid solution gives violet color on introduction of tin foil.
Na_2,Ca,Al_2,Si with usually Mg, K_2, H_2, Fe_2 (perhaps a mixture of labradorite and Na. feldspar)	G. 2.68. BB fuses in thin splinters; *saccharite* only on thin edges. Imperfectly soluble in acids.
$*(R''(R_2)^{v'})(Si'^{v}O_3'')_4''$. R''=Fe,Mg, Ca, and H_2. $(R_2)^{v'}=(Al_2)$, (Fe_2)	G. ± 3. BB thin splinters fuse with difficulty to a gray glass; with borax, slowly to glass colored by Fe. Gelatinizes with HCl.
$((Al_2)^{v'}O_2'')''(Si'^{v}O_3'')''$	G. ± 3.2. BB infusible. With Co solution, blue color. Not decomposed by acids.
$((Al_2)^{v'}O_2'')''(Si'^{v}O_3'')''$	G. 3.6. (Same as preceding.)
$*Mg''(Si'^{v}O_3'')''$. Contains often Al_2, Fe, Mn, and Ca	G. ± 3.2. Almost infusible. Only rounded on thin edges. Insoluble in HCl.
$*(R_3''(Al_2)^{v'})^{xv'''}(Si_6'^{v}O_{21}'')^{xv'''}$ or $*(R_3''((Al_2)_2'^{v}O_3'')^{v'})(Si'^{v}O_3'')_6''$ with little water. R''=Mg'', Ca'', Na_2', K_2', with some H_2'. $(R_2)^{v'}=(Al_2)^{v'}$, $(Fe_2)^{v'}$	G. ± 2.7. Fuses easily with intumescence to white blebby glass. Imperfectly decomposed by HCl. *Para-silicate.*
$*(Na_2'Ca_3''(Al_2)_2^{v'})^{xxv'}(Si_9'^{v}O_{27}'')^{xxv'}$ or $*(Na_2'Ca_3''((Al_2)_3'^{v}O_4'')^{x})(Si'^{v}O_3'')_9''$ some water, K, and Fe_2	G. 2.7. In closed tube yields small amount of water. BB (like preceding). *Para-silicate.*
$*Mn''(Si'^{v}O_3'')''$. Containing usually some Fe, Mg, Ca, and H_2O, and rarely Zn	G. ± 3.5. BB blackens and fuses with slight intumescence. Amethyst glass with borax. *Fowlerite* gives, with soda on coal, reaction for Zn. In powder partially dissolves in HCl, and insoluble portion becomes white. Darkens on exposure to air.
$Mn_2''(SiO_4)''$. Some Fe always, and Mg, Ca, Zn sometimes	G. ± 4.6. BB fuses at 3.5 to a black scoria. Gelatinizes without evolving Cl.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Titanite†	greasy, partly vitreous and adamantine	brown green yellow black(seld.) white(seld.)	5.75.	monoclinic	I (nearly perfect)
Chloritoid†	on cleavage planes pearly	green	5.75	crystalline	perfect in one direction
Diopside†	vitreous	green white	5.75	monoclinic	I (perfect)
Leucite†	vitreous to resinous	gray white	5.75	isometric	.....
Tremolite **Calamite** (V. Amphibole)	vitreous	green gray white	5.75	monoclinic	I (perfect)
Nephrite‡	feebly lustrous to earthy	green white gray	5.75	crypto-crystalline	fracture splintery
Meionite‡	vitreous	white	5.75	tetragonal	i–i (perfect)
Omphacite‡	vitreous	green	6	monoclinic (?)	in two directions. In one to perf., in the other to dist.
Diaspore†	vitreous i–ɪ pearly	white	6	orthorhombic	i–ɪ (perfect)

CHEMICAL FORMULA.	REMARKS.
$*(Ti_4'^{V}Ca_6'')(Si'^{V}O_4'')_7'^{V}(?)$	G. ± 3.5. BB some varieties change color and fuse with intumescence to a yellow, brown, or black glass. With borax, a clear yellowish-green glass. Imperfectly soluble in hot HCl. With tin, in concentrated acid, a violet color; with microcosmic salt, in R.F., violet bead masked when Fe is present, and must then be treated on coal with tin.
$*(R''(R_2)^{V'})(Si'^{V}O_4'')_2'^{V}+H_2O$. R''= Fe, Mg; $(R_2)^{V''}=(Al_2)^{V''}(Fe_2)^{V''}$	G. ± 3.5. In matrass yields water. BB nearly infusible. Becomes darker and magnetic.
$*(Ca''Mg_2'')(Si'^{V}O_3'')_4''$. Generally containing some Fe, and sometimes Al_2 and Mn	G. ± 3.3. BB with difficulty fusible. Crystal sometimes divided by basal plane into a green and a white half.
$*(R''(Al_2)^{V'}(Si'^{V}O_3'')_4''$. R''=Ca'', Na_2', K_2', and sometimes H_2'	G. ± 2.5. BB infusible. With cobalt solution gives blue color. Decomposed by HCl without gelatinizing.
$*(Ca''Mg_2'')(Si'^{V}O_3'')_4''$ [D 9, distributing Fe'' between Mg and Ca]. Generally Fe and a little H_2O, and sometimes Mn	G. ± 3.2. With difficulty fusible.
$*(Ca''Mg_2'')(Si'^{V}O_3'')_4''$ [D 9, distributing Fe'' between Mg and Ca]. Generally Fe and a little H_2O, and sometimes Mn	Nephrite is a tough, compact, fine-grained Tremolite having a tinge of green or blue.
$((R_2)_8'^{V}R_6'')^{XXXV'}(Si'^{V}O_4'')_9'^{V}$. R''= Fe'', Mg'', Ca'', Na_2', K_2'; $(R_2)^{V'}=(Al_2)^{V'}$, $(Fe_2)^{V'}$	G. ± 2.7. Fuses with intumescence to white blebby glass.
$*R_{18}''(Al_2)_2'^{V})^{XLV'''}(Si_{19}'^{V}O_{62}'')^{XLV'''}$ [D 2](?). R''=Ca, Fe, Mg, Na_2', and K_2', with some water	G. ± 3.2. Either a mixture of two or more silicates or a *para-silicate*. BB, owing to variableness of composition, unreliable.
$H_2(Al_2)^{V'}O_4''$ or $(Al_2'^{V}O_2'')''(OH)_2'$	G. ± 3.4. In closed tube decrepitates strongly, separating into pearly white scales, and finally yields water. Infusible. With cobalt solution, deep blue. Some varieties react for iron. Not attacked by acids, but after ignition soluble in H_2SO_4. Trichromatic.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Turquois†	feebly waxy	bluish green	6	amorphous	fracture conchoidal to uneven
Helvite‡ (Helvin)	resinous to vitreous	yellow	6	isometric	1 (in traces)
Hyalite‡ (Var. Opal)	vitreous seldom pearly	white	6	amorphous	fracture conchoidal
† **Spodumene**†	vitreous i–ī pearly	gray white green	6	monoclinic	i–ī (distinct) I (less so)
Augite (Variety of Pyroxene)	vitreous	black	6	monoclinic	I (indistinct) O sometimes perfect
Hypersthene†	vitreous resinous i–ĭ metall'd pearly	blackish brown brownish black	6	orthorhombic	i–ĭ (perfect) I and i–ī (dist. but interr'ed)
Saussurite‡ (Dyscolite)	vitreous resinous I pearly	white	6	orthorhombic	I (distinct) fract. conch'al
Octahedrite† (Anatase)	adamantine	in all colors, most freq'ly red, black, and gray	6	tetragonal	O (perfect) I (distinct)
† **Nephelite**‡	vitreous	white gray pale yellow	6	hexagonal	I (distinct)
Elæolite‡ (Var. Nephelite)	greasy	green red brown	6	hexagonal	I (distinct)

CHEMICAL FORMULA.	REMARKS.
$((Al_2)_2{}^{VI}O'')(P^{V}O_5'')_2{}^{V} + 5(H_2O)$ with some Cu	G. $\pm$ 2.7. BB in closed tube decrepitates, yields water, and turns brown and black. BB in forceps becomes brown and glassy, but does not fuse. Colors flame green. With borax, bead in O.F., which is yellowish green, and pure green on cooling. Soluble in HCl.
Mixed Silicate and Sulphide. Silicate $R''(Si^{IV}O_3'')''$. R''=Be, Mn'', Fe''. $R''S''$; R''=Mn''	G. $\pm$ 3.2. Fuses in R.F. to yellowish-brown opaque bead with intumescence. Reacts for Mn. Decomposed by HCl with evolution of H_2S and separation of gelatinous silica.
$Si^{IV}O_2'' + x(H_2O)$. Contains usually some Fe, Al_2, Ca, Na, and K	G. $\pm$ 2. Clear as glass and colorless, constituting globular concretions.
$(R_3''(Al_2)_4{}^{VI})(Si^{IV}O_3'')_{15}'' +$ tr. H_2O. R''=Li_2', Na_2', Ca'', K_2', and some H_2'	G. 3.1. BB becomes white and opaque; swells up, and gives red color to flame. Fuses to a clear or white glass. Not dissolved by acids.
$R''(Si^{IV}O_3'')''$ [N]. R''=Ca, Mg, Fe'', and sometimes Mn''. Al_2 and Fe_2 occur in varying proportions, with sometimes Mn and H_2O	G. $\pm$ 3.3.
$(Fe''Mg_2'')(Si^{IV}O_3'')_3'' +$ a little H_2O. Usually contains Al_2, Ca, and sometimes Mn	G. $\pm$ 3.4. Fuses to a black enamel, and on coal yields magnetic mass.
$*((R_2)_{16}{}^{VI}R_{12}'')^{LXX''}(Si_{21}{}^{IV}O_{78}'')^{LXX''}$ [D]. R''=Mg'', Ca'', and H_2'; $(R_2)^{VI}$=$(Al_2)^{VI}$,$(Fe_2)^{VI}$. (*Ortho-acid* $H_{84}Si_{21}O_{84}$)	G. $\pm$ 3.2. BB swells up and fuses to a white blebby mass. Not decomposed by acids, but after ignition gelatinizes with HCl.
$Ti^{IV}O_2''$	G. $\pm$ 3.9. BB infusible. With microcosmic salt, in R.F., bead, which becomes violet on cooling.
$*(R''(R_2{}^{VI}O'')'^{VI})(Si^{IV}O_3'')_2''$. R''=Ca'', K_2', Na_2', and a little H_2'; $(R_2)^{VI}$=$(Al_2)^{VI}$ and $(Fe_2)^{VI}$	G. $\pm$ 2.6. Fuses quietly to a colorless glass. Gelatinizes with acids.
$*(R''R_2{}^{VI})(Si^{IV}O_4'')_2'^{IV}$. R''=Na_2', K_2', Ca'', and some H_2'; $R_2{}^{VI}$=$(Al_2)^{VI}$,$(Fe_2)^{VI}$	G. $\pm$ 2.6. Fuses quietly to a colorless glass. Gelatinizes with acids.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Orthoclase (Potassium Felspar)	vitreous O generally pearly	white red gray yellow	6	monoclinic	O (perfect) i–ī (distinct)
Microclin§ (Sodium-potassium Orthoclase)	vitreous O pearly	gray red green	6	monoclinic	O (perfect) i–ī (distinct)
Albite (Sodium Felspar)	vitreous O pearly	generally white or red	6	triclinic	O (perfect) i–ĭ (perfect) i–ī (less so) 1–ī (in traces)
Labradorite (Sodium-calcium Felspar)	vitreous to resinous O pearly	white gray	6	triclinic	O (perfect) i–ĭ (less so)
Anorthite (Calcium Felspar)	vitreous O pearly	white	6	triclinic	O (perfect) i–ĭ (perfect)
Oligoclase	vitreo-pearly or waxy to vitreous	white greenish or reddish	6.5	triclinic	O perfect i–ĭ less so

V. Very

Prehnite†	vitreous pearly	pale green	6.5	orthorhombic	O (perfect) I (distinct)
Epidote	vitreous	green yellow red (seld.)	6.5	monoclinic	i–ī (perfect) 1–ī (less so)
Zoisite†	vitreous i–ĭ pearly	gray green	6.5	orthorhombic	i–ĭ (very perfect)

CHEMICAL FORMULA.	REMARKS.
*$(K_2'Al_2^{V'})^{V''''}(Si_6'^{V}O_{16}'')^{V''''}$. K replaced by Na in varying proportions, but less than 1:1; also contains usually a little $Fe_2^{V'}$, Ca'', Mg'', and sometimes a little water.	G. ± 2.5. Never shows twin striation on O. BB fuses with great difficulty. Varieties containing Na are much more fusible. Not acted upon by acids. *Para-silicate.*
*$(R_2',Al_2^{V'})^{V''''}(Si_6'^{V}O_{16}'')^{V''''}$. R' = K' and Na'. Proportion of Na to K, 1:1	G. ± 2.6. Very seldom shows fine twin striation on O. Occasionally exhibits play of colors on this face. *Para-silicate.*
*$(Na_2'Al_2^{V'})^{V''''}(Si_6'^{V}O_{16}'')^{V''''}$. Contains almost always some Fe, Ca, and frequently Mg and some K	G. ± 2.6. Often showing twin striation on O. Fuses to a colorless white glass imparting yellow color to flame. *Para-silicate.*
*$(Ca''Al_2^{V'})^{V''''}(Si_8'^{V}O_{10}'')^{V''''}$. Contains almost always Na and Fe_2, and often Mg, K, and some H_2O	G. ± 2.7. BB fuses to colorless glass. Decomposed with difficulty by HCl, and generally but partially. *Para-silicate.*
*$(Ca''Al_2^{V'})(Si'^{V}O_4'')_2'^{V}$	G. ± 2.7. BB fuses to colorless glass. From Mt. Somma decomposed by HCl with separation of silica. *Para-silicate.*
$Na_4,(Al_2)_3,Si_{12},O_{19}$. Always some Ca, and usually Mg, Fe_2, Ka, sometimes H_2O	G. 2.56. Fuses at 3.5 to a clear enamel. Not affected by acids.

Hard.

*$(Ca_2''(Al_2'^{V}O_2'')'')(Si'^{V}O_3'')_3''+H_2O$ or $(H_2'Ca_2''Al_2^{V'})(Si'^{V}O_4'')_3'^{V}$ Al_2 partially replaced by Fe_2, and sometimes by Mn_2. Occasionally contains K and Na	G. ± 2.8. In closed tube yields water. BB fuses with intumescence to blebby enamel-like glass. Decomposed by HCl without gelatinizing.
*$(Ca_4''((R_2)_3^{V'}O''))(Si'^{V}O_4'')_6'^{V}$ + $4(H_2O)$ [Tschermak]. R'' = Mn, Mg, Ca, H_2; $(R_2)^{V'} = Al_2$, Fe_2	G. 3.2—3.5. In closed tube generally gives water. Fuses with intumescence to dark brown or black mass, which is generally magnetic. Reacts for Fe and sometimes for Mn with fluxes. Partially decomposed by HCl, but when first ignited gelatinizes with acid.
*$(R_6''(R_2)_4^{V'})(Si'^{V}O_4'')_9'^{V}$ [N]. R'' principally Ca'' with N_2' and Mg''. $R_2^{V'} = Al_2^{V'}$ and $Fe_2^{V'}$	G. ± 3.2. BB swells up and fuses to white blebby mass. Not decomposed by acids. Previously ignited gelatinizes with HCl.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Allanite† (Orthite)	vitreous	black	6.5	monoclinic	i–ī (traces) fracture conchoidal
Chondrodite†	vitreous to resinous	yellow brown	6.5	orthorhombic	.....
Augite (Conchoidal)	vitreous	black	6.5	monoclinic	I (perfect) fracture perfectly conch'al
Rutile† (In part)	adamantine	red brown	6.5	tetrag.	I (perfect) i–ī (distinct)
Cassiterite†	adamantine	black brown yellow(sel.) red (seld.) white (very seldom)	6.5	tetrag.	I (perfect) i–ī (distinct)
Fibrolite‡	feeble	gray yellow green	6.5	monoclinic	i–ī (very perfect) brilliant
Chrysolite†	vitreous	green yellow	6.75	orthorhombic	i–ī to distinct
Obsidian† (Includ. Pumice) (Volcanic Glass)	vitreous	black, gray, also green, and brown	6.75	amorphous	fracture perfectly conch'al
Quartz	vitreous on surfaces of fracture resinous	colorless and white, but also in all colors	7	hexagonal	R very seldom dist. Fracture partly conc'al, pt. even, pt. splintery

CHEMICAL FORMULA.	REMARKS.
*$(R''(R_2)^{V'})(Si^{IV}O_4'')_2'^{V}$. R″ = Ce, Ca, Fe, Mn, Mg, and H_2' with Y, and sometimes La and D; $(R_2)^{V''}$ = Al_2, Fe_2	G. 3 — 4.2. Some varieties give water in closed tube. BB fuses easily, and swells to a dark blebby magnetic glass. With fluxes reacts for iron. Most varieties gelatinize with HCl.
Principally Magnesium silicate with Magnesium fluo-silicate, in the proportion of 8 of the former to 1 of the latter	G. ± 3.1. BB infusible. Some varieties blacken and then burn white. Fused with microcosmic salt, in open tube, reacts for F. With fluxes, reaction for Fe. Gelatinizes with acids.
*$R''(Si^{IV}O_2'')''$ [N]. Always Ca; generally Mg″, Fe″, and sometimes Mn″. Al_2 and Fe_2 are found in varying proportions	G. ± 3.2.
*$Ti^{IV}O_2''$	G. ± 4.2. BB infusible. In microcosmic salt colorless bead, which, in R.F., becomes violet on cooling.
*$Sn^{IV}O_2''$	G. 6.4 — 7.1. BB alone unaltered. With soda, in R.F., white coat; but slightly acted upon by acids.
$((Al_2)^{V'}O'')''(Si^{IV}O_3'')''$	G. ± 3.2. Infusible. With cobalt solution gives a blue color. Not decomposed by acids.
*$R_2''(Si^{IV}O_4'')^{IV}$ [N]. R″ = principally Mg″ with some Fe″, also tr. of Co, Ni, and Al_2	G. ± 3.4. BB whitens, but is infusible. With fluxes gives reactions for Fe. Some varieties give reaction for Ti and Mn. Decomposed and gelatinizes with HCl and H_2SO_4.
Contains K, Al_2, Si, O, and Mg, Ca, Fe_2, and Na	G. 2.25 — 2.8. Principally Orthoclase in glassy state. Sometimes a mixture of Orthoclase, Labradorite, and Augite with Chrysolite and much iron.
*$Si^{IV}O_2''$, with many impurities, but principally Fe	G. ± 2.7. BB alone unaltered. With soda dissolves with effervescence. Unacted upon by microcosmic salt. Soluble only in HF.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Chalcedony (Var. Quartz)	on planes of fracture lustrous in spangles to earthy	in all colors	7	crypto-crystalline	fracture in the large, even to conchoidal; in the small, fine splintery
†**Vesuvianite**† (Idocrase)	resinous partly vitreous	brown gray yellow red	7	tetrag.	.....
†**Garnet**	vitreous resinous	red, brown, yellow, and also in all colors	7	isometric	I (sometimes observable)
†**Axinite**‡	vitreous partly adamantine	brown	7	triclinic	i–ī (quite distinct)
†**Tourmaline** (Var. I. is brown) (Var. II. is red)	vitreous	black, brownish black, bluish black, blue, green, red, transparent, and in all colors	7	hexagonal (rhombohedr'l)	.....
†**Iolite**‡ (Cordierite)	vitreous	blue green	7.25	orthorhombic	O (distinct)
Boracite‡	vitreous partly adamantine	white gray	7.25	isometric	1 (in traces)

CHEMICAL FORMULA.	REMARKS.
$Si^{IV}O_2''$	G. ± 2.7. Either transparent or translucent.
$*(R_{18}''(R_2)_4^{V'})(Si^{IV}O_4'')_{15}^{IV}$ [v. Ram. N]. R″ = Fe, Mn, Mg, Ca, and a little H_2'; $(R_2)^{V'}$ = Al_2, Fe_2	G. ± 3.4. Fuses with intumescence to a greenish or brownish glass. With fluxes gives iron reaction. After ignition completely decomposed by HCl.
$*(R_6''(R_2)_2^{V'})(Si^{IV}O_4'')_6^{IV}$ [N]. R″ = Ca, Fe, Mn, Mg, and occasionally K_2', Na_2'; $(R_2)^{V'}$ = Al_2, Fe_2, Cr_2	G. 3.1—4.3. Most varieties fuse easily to light-brown or black glass. Almost all varieties react for Fe. The other reactions vary with the bases. Almost all are decomposed after ignition by HCl, and usually with separation of gelatinous silica.
$*(R_2''(R_2)^{V?})^x(Si_2^{IV}O_{11}'')^x$ or $(Si^{IV}O_3'')(R_2''(R_2)^{V'})(Si^{IV}O_4'')_2^{IV}$ [N] (?). R″ = Ca, Mg, K_2'; $(R_2)^{V'}$ = Al_2, Fe_2, Mn_2	G. ± 3.3. Fuses easily with intumescence, and imparts pale green to flame, and fuses to dark-green to black glass. With borax an amethyst-colored bead in O.F. Fused with $KHSO_4$ and fluorite on platinum wire gives green flame. Not decomposed by acids. Gelatinizes with HCl.
I. $*(B'''O_3'')_2'(R_3''(Al_2)_2^{V'})$-$(Si^{IV}O_4'')_4^{IV}$ [N] II. $*(B'''O_3'')_4'(R_2''((Al_2)_6^{V'}O''))$-$(Si^{IV}O_4'')_9^{IV}$ [N] R″ = Be, Mg, Ca, Na, K_2', Li_2', Fe. Contains Fe_2, F, and sometimes Mn_2	G. 2.9—3.3. Not decomposed by acids. BB varies very much for different varieties. After fusion perfectly decomposed by H_2SO_4. Dichroic. Pyroelectric.
$*(Si^{IV}O_4'')_3^{IV}(Mg_2''(Al_2)_2^{V'}O'')$-$(Si^{IV}O_3'')_3''$ [N]. R″ = Mn″, Mg, some H_2', and sometimes Ca and Li_2'; $(R_2)^{V'}$ = Al_2, and sometimes Fe_2	G. ± 2.6. BB loses transparency and fuses. Only partially decomposed by acids.
Magnesium Borate and Chloride, in the proportion of six parts of the former to one of the latter (?)	G. ± 3. Massive variety gives water in closed tube. BB fuses to white crystalline pearls, coloring flame green. With cobalt solution assumes deep-pink color. Mixed with CaO and heated on coal gives flame deep-blue color.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Spherulite§ (Var. Pearlstone)	feeble to earthy	brown gray red	7.25	amorphous	fracture conchoidal, even, splintery
Andalusite†	vitreous	red gray	7.25	orthorhombic	I (perfect) i–ī (less so) i–ĭ (in traces)
Schorlomite‡ (Schorlamit)	vitreous	black	7.25	?	fracture large faces, conchoidal; small, splintery
Staurolite†	vitreous	brown black	7.5	orthorhombic	i–ĭ (distinct but interrupted)
Beryl† (Of which Emerald is a variety)	vitreous	green blue white yellow red	7.5	hexagonal	O (distinct) I (less so)
Zircon† (Of which Hyacinth is a var.)	adamantine	colorless, pale-yellowish green, brownish-yellow, reddish, and in all colors except black	7.5	tetrag.	I (distinct)
Chrysoberyl†	vitreous	green yellow	7.75	orthorhombic	1–ĭ (quite distinct) i–ĭ (imperfect) i–ī (more so)
Spinel†	vitreous	black red *less freq'tly* gray blue brown	7.75	isometric	sometimes O (observable)

CHEMICAL FORMULA.	REMARKS.
Contains K, Al_2, SiO_2, and other substances	G. ±2.3. Impure, massive, glassy, spheroidal Orthoclase. Properly a *rock*.
$((Al_2)^{\prime\prime\prime}O_2^{\prime\prime})^{\prime\prime}(Si^{\prime\prime\prime}O_3^{\prime\prime})^{\prime\prime}$	G. ±3.1. BB infusible. With cobalt solution, a blue color. Not decomposed by acids.
Si, Ti, $Fe_2^{\prime\prime\prime}$, Fe″, Ca, Mg, and sometimes Va. R″ = Ca, Mg; $R^{\prime\prime\prime}$ = Ti, Si; $R_2^{\prime\prime\prime}$ = Fe_2	G. ±3.8. BB fuses quietly to a black glass. Reacts for Fe. With microcosmic salt on coal, and tin in R.F., violet bead. Gelatinizes with HCl, the solution becoming violet when boiled with metallic tin.
$*(R^{\prime\prime}((R_2)_2^{\prime\prime\prime}O_3^{\prime\prime})^{\prime\prime\prime\prime})(Si^{\prime\prime\prime}O_4^{\prime\prime})_2^{\prime\prime\prime}$. R″ = Fe″, Mg″, and probably a little H_2′; $(R_2)^{\prime\prime\prime}$ = $(Al_2)^{\prime\prime\prime}$, $(Fe_2)^{\prime\prime\prime}$, $(Mn_2)^{\prime\prime\prime}$	G. ±3.6. BB infusible, except the Mn variety, which fuses to a black magnetic glass. With fluxes reacts for Fe and sometimes for Mn. Imperfectly decomposed by H_2SO_4.
$*(Be^{\prime\prime}O_2^{\prime\prime})_5^{\prime\prime}((Al_2)_3^{\prime\prime\prime}O_3^{\prime\prime})^{x/v}(Si^{\prime\prime\prime}O_4^{\prime\prime})^{y\prime\prime\prime}$ or $Be_5^{\prime\prime}$–$O_{10}^{\prime\prime}$–$((Al_2)_3^{\prime\prime\prime}O_3^{\prime\prime})^{x/v}$–$O_4^{\prime\prime}$–$Si^{\prime\prime\prime}$ [Dumenil] (?)	G. ±2.7. BB unchanged or becomes clouded. Glass with borax, clear for beryl: fine green for emerald. Slowly soluble with microcosmic salt without leaving siliceous skeleton. Undissolved by acids.
$*Zr^{\prime\prime\prime}(Si^{\prime\prime\prime}O_4^{\prime\prime})^{\prime\prime\prime}$	G. 4—4.7. Infusible. The colorless varieties are unaltered; the red becomes colorless. Not perceptibly attacked by microcosmic salt. Powder is decomposed by fusion with soda on platinum wire, and if the product is dissolved in dilute HCl, gives the characteristic orange color with turmeric paper.
$*Be^{\prime\prime}Al_2^{\prime\prime\prime}O_4^{\prime\prime}$	G. ±3.7. BB alone unaltered. With soda the surface is merely rendered dull. With borax or microcosmic salt fuses with great difficulty. With cobalt solution the powder gives a bluish color. Insoluble in acids.
$*Mg^{\prime\prime}Al_2^{\prime\prime\prime}O_4^{\prime\prime}$	G. 3.5—4.9. BB alone infusible. Red variety changes to brown or black, and becomes opaque. On cooling becomes green, then nearly colorless, and finally resumes its red color. Slowly soluble in borax and microcosmic salt, with which it gives reddish bead, becoming green by cooling. Soluble with difficulty in H_2SO_4.

NAME.	LUSTRE.	COLOR.	HARD'SS	CRYSTAL SYSTEM.	CLEAVAGE.
Topaz	vitreous partly to adamantine and on O pearly	straw or wine yellow, blue white *less freq'tly* green blue brown	8	orthorhombic	O (perfect)
Corundum† (Of which Ruby and Sapphire are varieties)	vitreous	blue red *less freq'tly* green gray brown white	9	hexagonal (rhombohedr'l)	R (distinct) O (sometimes perfect but interrupted)
Diamond†	adamantine	in all colors most freq'ly white or colorless	10	isometric	1 (highly perfect)

CHEMICAL FORMULA.	REMARKS.
$*((Al_2)_6{}^{VI}F_{10}{}'O'')^{XX/V}(Si^{IV}O_4'')_6{}'^{V}$ [von Rammelsberg.]	G. ± 3.5. BB infusible. Some varieties take a wine-yellow or pink tinge when heated. Fused in open tube with microcosmic salt gives reaction for F. With cobalt solution the powder gives fine blue. Only partly attacked by H_2SO_4.
$Al_2{}^{VI}O_3''$	G. ± 4. BB unaltered. Slowly dissolved in borax and microcosmic salt to a clear glass, which is colorless when free from iron. Not acted upon by soda. Finely powdered mineral gives blue color with cobalt solution. Not acted upon by acids. Friction develops electricity.
C	G. 3.5. Burns to CO_2. Is not acted upon by acids or alkalies.

SUPPLEMENT-

TO ASSIST IN THE DETER-

OF NON-METALLIC LUSTRE

A. More or less easily

NAME.	HARDNESS.	TASTE.
Natron (Efflorescite)	1.25	alkaline.
Sassolite	1.5	sour, then cooling and bitter, and lastly sweetish.
Glauberite	1.75	cooling, bitter-salt.
Sal-ammoniac	1.75	pungent salt.
Soda Nitre	1.75	cooling salt.
Nitre	2	cooling salt.
Borax (Tinkal)	2	weak sweetish alkaline.
Alunogen (Keramohalite)	2	astringent.
Halotrichite	2	astringent.

ARY TABLES

MINATION OF MINERALS

AND COLORLESS STREAK.

soluble in water.

NAME.	HARDNESS.	TASTE.
Melanterite (Copperas, Green Vitriol)	2	sweetish, astringent, and metallic.
Chalcanthite (Blue Vitriol, Copper Vitriol)	2.25	nauseous and metallic.
Goslarite (White Vitriol, Zinc Vitriol)	2.25	astringent, metallic, and nauseous.
Epsomite (Bitter Salz)	2.25	bitter and saline.
Tschermigite (Ammonium Alum)	2.25	astringent.
Kalinite (Potassium Alum)	2.25	astringent.
Halite	2.5	pure saline.
Carnallite	2.75	weakly pungent salt.

B. Insoluble in water, effervescing

NAME.	HARDNESS.	FUSIBILITY BB IN THE PLATINUM FORCEPS OR ON COAL.
Hydrozincite (Zinkblüthe)	2.5	infusible.
Caledonite	2.75	easily fusible.
Phosgenite (Bleihornerz)	2.75	easily fusible.
Calcite	3	infusible,—glows brightly.
Cerussite (Weissbleierz)	3	fuses easily, and yields in R.F. metallic lead.
Witherite	3.75	easily fusible.
Strontianite	3.75	infusible,—glows.

with dilute (warm) hydrochloric acid.

NAME.	HARDNESS.	FUSIBILITY BB IN THE PLATINUM FORCEPS OR ON COAL.
Aragonite	4	infusible,—glows brightly.
Dolomite	4	infusible.
Siderite	4	infusible.
Smithsonite	4.5	infusible.
Rhodochrosite	4.5	infusible.
Magnesite (Talkspath crystallized)	4.5	infusible,—glows.
Magnesite (Compact fine granular)	5	infusible.

C. Insoluble in water, not

I. YIELDING WATER

PULVERIZED.	IN THE CANDLE-FLAME.	
IN COLD OR WARM, DILUTE OR CONCENTRATED, HYDROCHLORIC ACID.	VOLATILE OR FUSIBLE.	
	NAME.	HARD'SS
Easily and perfectly soluble		
Perfectly but with difficulty soluble		
Perfectly and easily decomposable, with separation of perfectly gelatinous silica	Natrolite (A)	5.25
Perfectly and easily decomposable, with separation of pulverulent or imperfectly gelatinous silica	Apophyllite (A)	4.75
Perfectly but with difficulty decomposable, with separation of silica		
Imperfectly soluble or decomposable		

(A) in parenthesis indicates that the mineral

effervescing with HCl.

IN GLASS MATRASS.

BEFORE THE BLOW-PIPE.

EASILY FUSIBLE.		WITH DIFFICULTY FUSIBLE.		INFUSIBLE.	
NAME.	HARD'SS	NAME.	HARD'SS	NAME.	HARD'SS
Haidingerite	2.25			Aluminite	1
Annabergite (Nickelblüthe)	2.25			Pissophanite	2
				Brucite	2
Pharmacolite	2.25			Mellite	2.75
Köttigite	2.25			Wavellite (A)	3.25
Scorodite	2.75			Peganite	3.5
Gypsum	2			Diaspore	6
Laumontite (A)	3.5				
Stilbite (Desmin)	3.75			Alumocalcite	1.5
Datolite (A)	5			Chrysocolla	2.75
Pectolite				Allophane (A)	3.25
Phillipsite (A)	5.25			Calamine (Kieselzinkerz)	4.75
Thomsonite (A)	5.5				
Analcite (A)	5.5				
Orthite (A)	6.5				
Smectite (Malthacite)	1				
Heulandite (A)	3.75	Meerschaum	2.25		
Chabazite (A)	4.5	Deweylite (Gymnite)	2.5	Dermatin	2.5
Apophyllite					
Faujasite (A)	5	Pimelite	2.75		
Harmotome	5.5				
Analcite (A)	5.5				
Smectite (Smectit)	1.25	Serpentine	3.5	Serpentine	2.5
		Collyrite	1.5	Kaolinite	1
Montmorillonite (Stolpenit)	1.75	Stilpnomelane	3.5	Pyrophyllite (A)	1.5
		Schillerspar or		Halloysite	2.25
Prehnite (A)	6.5	Bastite (var. Serpentine)	3.75	Alunite (A)	3.75
				Prosopite	4.5
				Lazulite (A)	5.5

BB intumesces, froths, and exfoliates or sprouts.

PULVERIZED.	IN THE CANDLE-FLAME.	
IN COLD OR WARM, DILUTE OR CONCENTRATED, HYDROCHLORIC ACID.	VOLATILE OR FUSIBLE.	
	NAME.	HARD'SS
Insoluble or undecomposable, or but little attacked	Könlite (Könleinit)	1
	Copalite (Retinit)	1.75
	Succinite (Amber) (Bernstein)	2.5

II. YIELDING LITTLE OR NO WATER

Perfectly and easily soluble	Senarmontite	2.25
	Valentinite (Weissspiesglaserz)	2.5
	Arsenolite (Arsenit)	2.75
Perfectly but with difficulty soluble	Amblygonite	5.5
Perfectly and easily decomposable, with separation of perfectly gelatinous silica		
Perfectly and easily decomposable, with separation of pulverulent or imperfectly gelatinous silica, or of plumbic chloride, or tungstic oxide		

BEFORE THE BLOW-PIPE.

EASILY FUSIBLE.		WITH DIFFICULTY FUSIBLE.		INFUSIBLE.	
NAME.	HARD'SS	NAME.	HARD'SS	NAME.	HARD'SS
Carpholite (A)	5	Agalmatolite	2.5	Muscovite (Nacrite)	<1
		Chlorite	2.5	Felsöbanyite	1.5
		Picrolite	4	Cerolite	2.25
		Pearl Stone (A)	5.25	Dillnite	2.75
		Pitch Stone	5.25	Opal	5.25
		Chloritoid	5.75	Turquois	6

WHEN HEATED IN THE GLASS MATRASS.

Triphylite	4				
Triplite	4.5	Apatite	5		
Meionite (A)	5.75				
Fluorite	4				
Boracite	7.25				
Eulytite (A) (Kieselwismuth)	4.75				
Haüynite	5	Wollastonite	4.5		
Nosite	5.5	Gehlenite	5.25	Willemite	5.5
Sodalite (A)	5.5	Sodalite (A)	5.5	Chondrodite	6.5
Tephroite		Nephelite	6	Chrysolite	6.75
Elæolite (A)	6	Orthite (A)	6.5		
Helvite (A)	6	Chrysolite	6.75		
Orthite	6.5				
Mendipite	2.75				
Wulfenite (Gelbbleierz)	3				
Stolzite (Scheelbleispath)	3	Scheelite	4.5		
		Anorthite	6	Leucite	5.75
Vanadinite	3				
Scapolite (A)	5.5				
Porcelain spar (A)	5.5				

PULVERIZED.	IN THE CANDLE-FLAME.	
IN COLD OR WARM, DILUTE OR CONCENTRATED, HYDROCHLORIC ACID.	VOLATILE OR FUSIBLE.	
	NAME.	HARD'SS
Perfectly but with difficulty decomposable with separation of silica		
Imperfectly soluble or decomposable	Calomel	1.5
	Cryolite	3
Insoluble, undecomposable or but little attacked	Cerargyrite	1.5
	Lepidolite (A)	2

BEFORE THE BLOW-PIPE.

EASILY FUSIBLE.		WITH DIFFICULTY FUSIBLE.		INFUSIBLE.	
NAME.	HARD'SS	NAME.	HARD'SS	NAME.	HARD'SS
Scapolite (A)	5.5	Anorthite	6		
Labradorite	6				
Fuchsite	2.5	Talc	1		
(Muscovite)		Steatite	1.5		
Muscovite	2.5	Muscovite	2.5		
Anhydrite	3	Biotite	2.75		
Anglesite	3	Barite	3		
(Vitriolbleispath)		Voltzite	3.5		
Celestite	3	(Leberblende)		Brookite	5.5
(Cölestin)		Sphalerite	4	Chiastolite	5.5
Pyromorphite	3.5	(Zinc-blende)		Cyanite or	5.5
Mimetite	3.5	Margarite	4.5	(Disthene)	
Margarite	4.5	Bronzite	5	Opal	5.25
Diaclasite	4.75	(Var. Enstatite)		Perofskite	5.5
Pyrgom(V.Pyrox.)	5	Wagnerite	5.25	(Perowskite)	
Bolopherite(A) "	5.5	Enstatite	5.5	Hyalite	6
Erlanite (?)	5.5	Titanite (A)	5.75	Octahedrite	6
Rhodonite	5.5	Nephrite (A)	5.75	Rutile	6.5
Diopside(V.Pyrx.)	5.75	(Var. Amphibole)		Cassiterite	6.5
Tremolite (A)	5.75	Hypersthene	6	Fibrolite	6.5
(Var. Amphibole)		Dyscolite or		Quartz	7
Kalamite (A) "	5.75	(Saussurite)	6	Chalcedony	7
Augite (V. Pyrox.)	6	(Var. Zoisite)		Tourmaline	7
Oligoclase	6	Orthoclase	6	Andalusite	7.25
Labradorite	6	Microclin	6	Staurolite	7.5
Omphacite (V.Px.)	6	(Var. Orthoclase)		Zircon	7.5
Hypersthene	6	Albite	6.25	Chrysoberyl	7.75
Spodumene (A)	6	Epidote (A)	6.5	Spinel	7.75
Epidote (A)	6.5	Zoisite (A)	6.5	Topaz	8
Zoisite (A)	6.5	Obsidian (A)	6.75	Corundum	9
Garnet	7	Tourmaline (A in	7	Diamond	10
Vesuvianite	7	part)			
(Idocrase)		Garnet	7		
Axinite	7	Cordierite	7.25		
Tourmaline (A)	7	Spherulite	7.25		
Schorlomite	7.25	Beryl	7.5		

MOHS'S SCALE OF HARDNESS.

DEGREE.	
1	Talc.
2	Gypsum or Halite.
3	Calcite.
4	Fluorite.
5	Apatite (crystallized variety).
6	Feldspar (Adularia).
7	Quartz.
8	Topaz.
9	Corundum.
10	Diamond.

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*SCALES OF FUSIBILITY.

PLATTNER'S.

1. Such as fuse to a bead. (*a*) Easily. (*b*) With difficulty.
2. Such as fuse only on the edge. (*a*) Easily. (*b*) With difficulty.
3. Such as are infusible.

V. KOBELL'S.

1. *Stibnite.*—Fusible in candle-flame in coarse splinters.
2. *Natrolite.*—Fusible in candle-flame in fine splinters. Easily fused before the blow-pipe in coarse fragments.
3. *Almandite*, or Iron Alumina Garnet.—Infusible in candle-flame, quite fusible before the blow-pipe in coarse fragments.
4. *Actinolite.*—Fusibility less than Almandite and greater than No. 5; fusible in coarse splinters.
5. *Orthoclase.*—Fusible in fine splinters.
6. *Bronzite.*—Only rounded on the edges in very fine splinters.

* (Plattner's Manual of Blow-pipe Analysis, Ed. Th. Richter. Translated by H. B. Cornwall, assisted by J. H. Caswell, New York, 1873.)

TABLE OF ELEMENTS WITH THEIR VALENCES AND ATOMIC WEIGHTS.

FOR REFERENCE IN COMPARING OR RECALCULATING FORMULAS.

NAME.	Symbol and Valence.	Atomic Weight.	NAME.	Symbol and Valence.	Atomic Weight.
†Aluminum	Al^{IV}	27.3	Mercury (Hydrargyrum)	Hg^{II}	200.
Antimony (Stibium)	Sb^{V}	122.	Molybdenum	Mo^{IV}	96.
Arsenic	As^{V}	75.	†Nickel	Ni^{IV}	59.
Barium	Ba^{II}	137.	Niobium	Nb^{V}	94.
Beryllium (Glucinum)	Be^{II}	9.4	Nitrogen	N^{V}	14.
Bismuth	Bi^{III}	210.	Osmium	Os^{IV}	199.2
Boron	B^{III}	11.	Oxygen	O^{II}	16.
*Bromine	Br^{I}	80.	Palladium	Pd^{IV}	106.
Cadmium	Cd^{II}	112.	Phosphorus	P^{V}	31.
Cæsium	Cs^{I}	133.	Platinum	Pt^{IV}	198.
Calcium	Ca^{II}	40.	Potassium (Kalium)	K^{I}	39.1
Carbon	C^{IV}	12.	Rhodium	Ro^{IV}	104.
Cerium	Ce^{II}	91.3	Rubidium	Rb^{I}	85.4
*Chlorine	Cl^{I}	35.5	Ruthenium	Ru^{IV}	104.4
†Chromium	Cr^{IV}	52.2	Selenium	Se^{II}	79.4
†Cobalt	Co^{IV}	59.	Silicium (Silicon)	Si^{IV}	28.
Columbium (?)	Cb^{II}	94.	Silver (Argentum)	Ag^{I}	108.
Copper	Cu^{II}	63.4	Sodium (Natrium)	Na^{I}	23.
Didymium	D^{II}	95.	Strontium	Sr^{II}	87.
Erbium	E^{II}	112.6?	Sulphur	S^{II}	32.
Fluorine	F^{I}	19.	Tantalum	Ta^{V}	182.
Gallium (?)	Ga	.....	Tellurium	Te^{II}	128.
Glucinum (Beryllium)	Gl^{II}	9.4	Thallium	Tl^{I}	204.
Gold (Aurum)	Au^{III}	197.	Thorinum (Thorium)	Th^{II}	231.
Hydrogen	H^{I}	1.	Tin (Stannum)	Sn^{IV}	118.
Indium	In^{IV}	113.4	Titanium	Ti^{IV}	50.
*Iodine	I^{I}	127.	Tungsten (Wolfram)	W	184.
Iridium	Ir^{IV}	198.	†Uranium	U^{IV}	120.
†Iron (Ferrum)	Fe^{IV}	56.	Vanadium	V^{V}	51.3
Lanthanum	La^{II}	93.	Yttrium	Y^{II}	61.6
Lead (Plumbum)	Pb^{IV}	207.	Zinc	Zn^{II}	65.
Lithium	Li^{I}	7.	Zirconium	Zr^{IV}	89.6
Magnesium	Mg^{II}	24.			
†Manganese	Mn^{IV}	55.			

* Occurs also as triad (^{III}), pentad (^{V}), and heptad (^{VII}).

† Occurs as *apparent* triad $(R_2)^{VI}=(R^{III})_2$. This is *only* apparent, and is supposed to be caused by a mutual saturation of two affinities in the double atom, $-\overset{|}{\underset{|}{(R-R)}}-$

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